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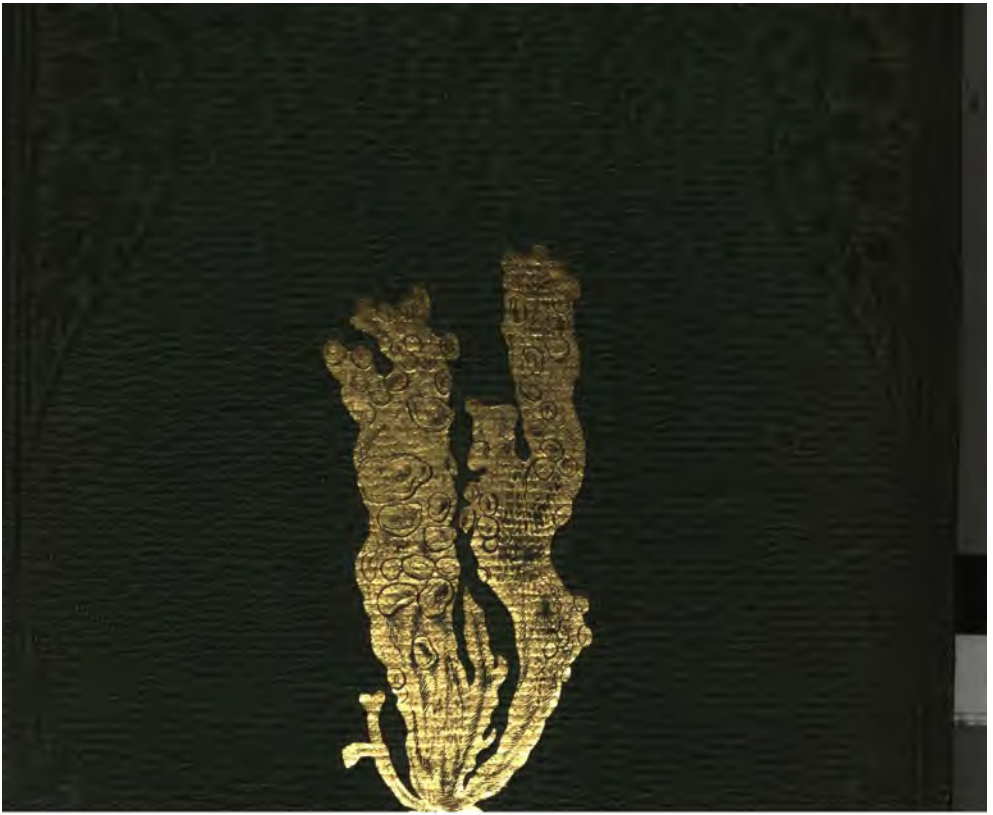
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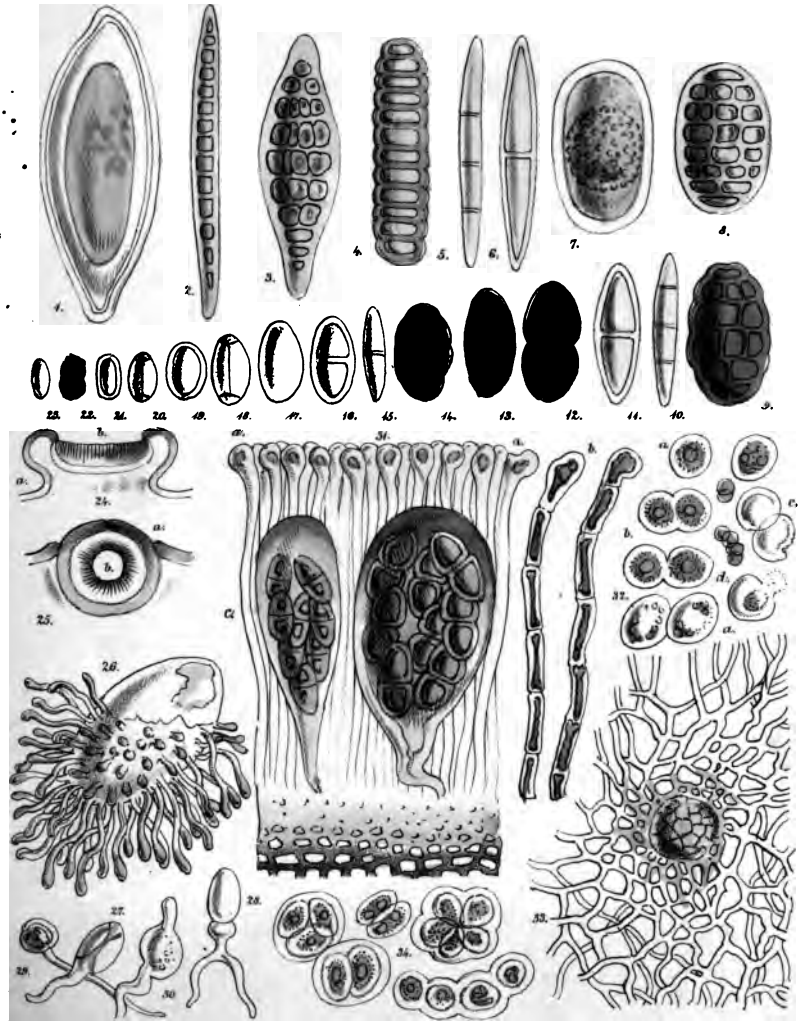
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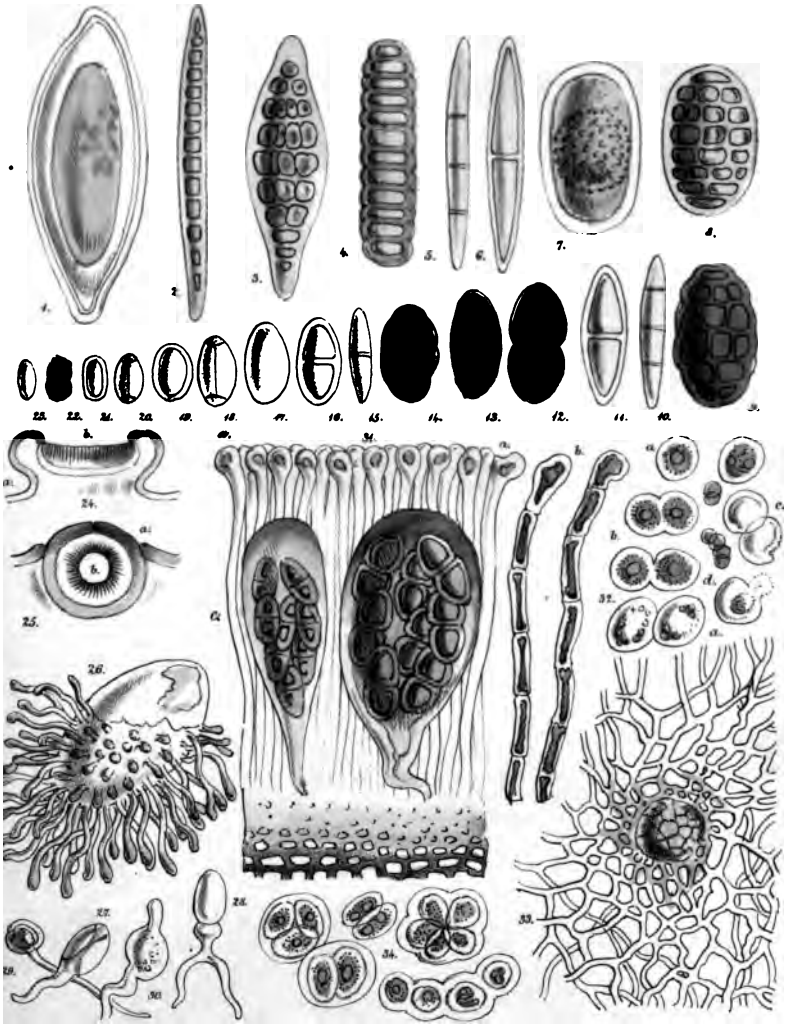


POPULAR

HISTORY OF BRITISH LICHENS.



Vincent Brooks Imp



Lindsay del. W. Fitch lith.

Vincent Brooks Imp

A

POPULAR HISTORY

OF

BRITISH LICHENS,

COMPRISING

AN ACCOUNT OF THEIR STRUCTURE, REPRODUCTION, USES, DISTRIBUTION, AND CLASSIFICATION.



BY

W. LAUDER LINDSAY, M.D.,

FELLOW OF THE BOTANICAL AND ROYAL PHYSICAL SOCIETIES OF EDINBURGH, ETC.

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TO

SIR WILLIAM JACKSON HOOKER, K.H., LL.D.,

DIRECTOR OF THE ROYAL BOTANIC GARDENS OF KEW,

AND

DR. JOSEPH DALTON HOOKER, F.R.S.,

ASSISTANT-DIRECTOR OF THE ROYAL BOTANIC GARDENS OF KEW,

THIS HUMBLE AND

FIRST ATTEMPT TO POPULARIZE THE STUDY OF

British Lichens

IS, WITH MUCH RESPECT AND ESTEEM, DEDICATED

BY

THE AUTHOR.

"In minimis Natura præstat."—PLINY.

"Natura maxime miranda in minimis."—LINNÆUS.

"A Lichen is as perfectly fitted to the condition it is intended to fulfil, and its organs as completely adapted to that purpose, as the stately palm or magnificent forest-tree."—BASKERVILLE.

"The man
Whom Nature's works can charm, with God himself
Holds converse."—THORNTON.

DESCRIPTION OF THE PLATES.*

PLATE I.

Figs. 1 to 23. Comparative size of spores.

1. *Pertusaria communis.*
2. *Opegrapha siderella.*
3. *Thelotrema lepadinum.*
4. *Aulacographa elegans.*
5. *Peltigera horizontalis.*
6. *Sticta scrobiculata.*
7. *Lecanora pallescens*, var. *parella.*
8. *Graphis scripta.*
9. *Urceolaria scruposa.*
10. *Stereocaulon paschale.*
11. *Solorina crocea.*
12. *Physcia ciliaris.*
13. *Verrucaria nitida.*
14. *Lecidea geographica.*
15. *L. æruginosa.*
16. *Ramalina fraxinea.*
17. *Umbilicaria polymorpha.*
18. *Lecidea ferruginea.*
19. *Lecanora subfusca.*
20. *Parmelia parietina.*
21. *Usnea barbata.*
22. *Calicium hyperellum.*
23. *Cladonia pyxidata.*

* The majority of the Illustrations are original. For the drawings of the spermogones and spermatia, pycnides and stylospores, and a few others, we are indebted to the Memoir of Tulasne. Several drawings illustrative of general characters or structure have been taken from the works of Leighton and

Fig. 24. Vertical section of a gymnocarpous apothecium.—*a*. Exciple. *b*. Thalamium.

25. Vertical section of an angiocarpous apothecium.—*a*. Exciple. *b*. Thalamium.

26–30. Germinating spores.

26. *Lecanora pallescens*, var. *parella*.

27, 28. *Parmelia parietina*.

29. *Sphærophoron compressum*.

30. *Lecanora subfusca*.

31. Vertical section of apothecium of *Physcia ciliaris*.—*a*. Paraphyses. *b*. Paraphyses acted on by iodine. *c*. Thecæ containing the spores, tinged blue by iodine. *d*. Hypothecium.

32. Gonidia.—*a*. Mature. *b*. In process of fissiparous division. *c*. Emptied of their contents. *d*. Nuclei or contents, after their escape.

33. Hypothallus developed around the spore of *Cladonia extensa*.

34. Gonidic mother-cells from young plants of *Parmelia parietina*.

PLATE II.

1. Vertical section of apothecium and thallus of *Parmelia parietina*.—*a*. Tuberose extremities of paraphyses. *b*. Thecæ con-

Schærer. In our own researches on the general or special microscopic anatomy of the Lichens, we have usually employed the magnifying power 380 of Nachet's (Parisian) microscope.

taining spores or protoplasm. *c*. Hypothecium. *d*. Gonidia. *e*. Medullary filaments. *f*. Cortical layer of thallus. *g*. Spore under action of iodine.

2. Spermogone of *Parmelia ceratophylla*, var. *physodes*.
3. Sterigmata of the same Lichen.
4. Spermatia, ditto.
5. Sterile spermogonal filaments, ditto.
6. Sterigmata and spermatia of *Sticta pulmonaria*.
7. Ditto ditto of *Calicium turbinatum*.
8. Ditto ditto of *Lecanora atra*.
9. Ditto ditto of *Lecanora subfusca*.
10. Ditto ditto of *Urceolaria scruposa*.
11. Sterigmata and spermatia of *Lichina pygmæa*.
12. Ditto ditto, of *Ramalina fraxinea*.
13. Pycnides of *Scutula Wallrothii*.
14. Sterigmata and stylospores of ditto.

PLATE III.

1. *Usnea barbata*, common form.
2. Ditto, apothecium showing fibrillose-radiate margin.
3. Ditto, section of apothecium magnified.
4. Ditto, var. *articulata*, showing the inflated and articulated condition of the thalline filaments.
5. Ditto, var. *plicata*, also showing articulated condition of thalline filaments.

PLATE IV.

1. *Cetraria aculeata.*
2. Ditto, apothecium magnified.
3. *Cornicularia ochroleuca.*
4. Ditto, apothecium magnified.
5. *Cornicularia vulpina.*
6. *C. jubata.*
7. Ditto, apothecium magnified.
8. Ditto, spore.
9. *Solorina crocea.*—*a*. Upper, and *b*, lower surface.
10. Ditto, apothecium magnified.
11. Ditto, spore.
12. *Solorina saccata.*
13. Ditto, vertical section of apothecium.
14. Ditto, apothecium magnified.
15. Ditto, spores germinating.

PLATE V.

1. *Roccella fuciformis*, from Lima, South America,—"Lima (thin) Orchella-weed."

2. *Roccella tinctoria*, large variety from Lima.—"Lima (thick) Orchella-weed."

3. Ditto, small dark variety, neither warted nor very sorediiferous, from the Cape de Verde Islands.—"Cape de Verde Orchella-weed."

4. Ditto, small pale variety, very sorediiferous, also from the Cape de Verde Islands.

5. Ditto, portion of a thalline filament magnified, showing small, patellæform apothecia with a proper exciple, *a*; large, irregular apothecia, without a proper exciple, *b*; and soredia, *c*.

6. Ditto, portion of a thalline filament magnified, showing these forms of the apothecium sectioned.

7. Ditto, section of one of the small apothecia more highly magnified.

8. Ditto, portion of a pale-warted, thalline filament of the thickest "Lima Orchella-weed."

9. Ditto, transverse section of ditto.

10. Ditto, portion of a black-warted and geniculate thalline filament of the thickest "Lima Orchella-weed."

11. Ditto, spore.

12. Ditto, spermatia of a variety.

PLATE VI.

1. *Ramalina fraxinea*, large variety.

2. Ditto, section of mature and young apothecia, *a*; and of thallus, showing spermogones, *b*.

3. Ditto, section of a spermogone, showing sterigmata, spermatia, and network of filaments.

4. Ditto, spores of specimens from various habitats, in different stages of development, *a* being mature, *b* old, and the remainder young.

5. Ditto, var. *fastigiata.*

6. Ditto, var. *calicaris.*

7. *R. scopulorum.*

8. *R. farinacea.*

9. Ditto, portion of thalline filament magnified, showing the soredia.

PLATE VII.

1. *Physcia prunastri.*

2. *P. furfuracea.*—*a.* Upper surface. *b.* Under surface.

3. *P. ciliaris.*

4. Ditto, under surface of thalline laciniæ.

5. Ditto, vertical section of thallus showing a spermogone.

6. Ditto, vertical section of a spermogone, showing the sterigmata and spermatia.

7. Ditto, vertical section of mature apothecium.

8. Ditto, vertical section of young apothecia.

9. Ditto, progressive development of the spore.

10. Ditto, segment of an old spore.

PLATE VIII.

1. *Cetraria Islandica*, large variety.

2. Ditto, common form.

3. Ditto, apothecium magnified.

4. Ditto, section of ditto.

5. Ditto, marginal cilia of thallus bearing the spermogones on their apices.

6. Ditto, two of these cilia greatly magnified, showing the spermogones.

7. Ditto, spermogone still more highly magnified.

8. Ditto, sterigmata and spermatia.

9. Ditto, spore.

10. Spore of *Cetraria juniperina.*

11. *Cetraria nivalis.*

12. Ditto, magnified, showing black-punctate margin.

13. Medullary tissue of *Peltigera venosa.*

14. Ditto, *P. horizontalis.*

15. Cortical cellular tissue of ditto.

16. Medullary filament of ditto, under the action of iodine.

PLATE IX.

1. *Peltigera canina,* upper surface.

2. Ditto, under surface, showing veins and rhizinæ.

3. Ditto, margin of thallus, showing spermogones and nascent apothecium.

4. Ditto, marginal spermogone magnified.

5. Ditto, vertical section of spermogone magnified.

6. Ditto ditto, much more highly magnified, showing sterigmata and spermatia.

7. Ditto, sterigmata.

8. Ditto, spermatia, isolated.

9. Ditto, spore.

10. *Peltigera horizontalis,* section of young apothecium.

11. *Peltigera horizontalis*, spore germinating.

12. *Peltigera polydactyla*, section of young apothecium.

13. *Peltigera venosa*, upper surface.

14. Ditto, under surface.

15. Ditto, spore.

16. *Nephroma resupinatum.*—*a*. Upper surface. *b*. Under surface, showing the apothecia.

17. Ditto, margin of thallus, showing spermogones and nascent apothecia.

18. Ditto, marginal spermogone magnified.

19. Ditto, section of ditto.

20. Ditto, spore.

21. Ditto, sterigmata and spermatia.

PLATE X.

1. *Umbilicaria pustulata*, upper surface.

2. Ditto, under surface.

3. Ditto, section of apothecium.

4. Ditto, muriform spore.

5. Ditto, section of apothecium, *a*, and of thallus, showing a spermogone, *b*.

6. Ditto, section of thallus, showing a spermogone, *a*, and a pustular elevation, *b*.

7. Ditto, sterigmata and spermatia.

8. *U. polymorpha*, common ciliated variety, upper surface.

9. Ditto, under surface, showing point of attachment, *a*.

10. *U. polymorpha*, portion of margin of the thallus, showing the cilia or fibrils.

11. Ditto, apothecia, in different stages of development: *a*, young and papillate; *b*, mature and gyrose-plicate.

12. Ditto, section of an apothecium, and of thallus showing the rhizinæ.

13. Ditto, portion of thallus of another variety, showing relative position of spermogones, *a*.

14. Ditto, section of thallus, showing spermogones.

15. Ditto, section of a spermogone.

16. Ditto, spores of different varieties.

17. *U. erosa*, spore.

PLATE XI.

1. *Sticta pulmonaria.*—*a*. Upper surface, showing apothecia and laciniæ. *b*. Lower surface, showing gibbi.

2. Ditto, extremity of a thalline lobule, magnified, showing spermogones, soredia, and apothecia, one of which, *a*, is habited by the *Celidium Stictarum*, a parasitic species.

3. Ditto, section of an apothecium, *a*; and of thallus showing old and young spermogones, *b*.

4. Ditto, spore.

5. Ditto, spore germinating.

6. *Sticta scrobiculata*, upper surface, showing the apothecia and marginal soredia.

7. Ditto, spore.

8. *S. fuliginosa*, upper surface, showing the soot-coloured powder of the margin.

9. Ditto, under surface, showing the white cyphellæ.

PLATE XII.

1. *Parmelia pulverulenta.*

2. Ditto, section of thallus, showing rhizinæ of under surface, magnified.

3. Ditto, section of apothecium, magnified.

4. Ditto, apothecium, showing its pruinose character.

5. Ditto, spore.

6. *Parmelia saxatilis*, furfuraceous variety.

7. Ditto, section of thallus, showing the rhizinæ of the under surface.

8. Ditto, section of apothecium.

9. Ditto, spores of var. *omphalodes.*

10. *Parmelia parietina.*

11. Ditto, portion of thallus magnified, showing marginal spermogones.

12. Ditto, section of apothecium, magnified.

13. Ditto, apothecium, magnified, common form.

14. Ditto, ditto, cephaloid or symphycarpeous form.

15. Ditto, vertical section of spermogone.

16. Ditto, sterigmata and spermatia.

17. Ditto, spore under action of iodine.

18. *Parmelia amplissima*, spore.

19. *P. læte-virens*, var. *herbacea*, spore.
20. *P. stellaris*, spore.
21. Ditto, under action of iodine.
22. *P. olivacea*, mature and young spores.

PLATE XIII.

1. *Lecanora Villarsii* (foreign species), vertical section of thallus, showing an apothecium, *a*, and a spermogone, *b*.
2. Ditto, section of spermogone.
3. Ditto, spermatia.
4. *L. orosthea*, section of a spermogone.
5. Ditto, sterigmata and spermatia.
6. *L. tartarea*.
7. Ditto, section of an apothecium.
8. Ditto, young apothecia, magnified.
9. Ditto, symphycarpeous or confluent apothecia.
10. *L. subfusca*.
11. Ditto, section of young apothecium, showing its concave condition.
12. Ditto, section of old apothecium, showing its convex condition.
13. *L. pallescens*, var. *parella*.
14. Ditto, young apothecia, magnified.
15. Ditto, section of an apothecium.
16. Ditto, spores in the earlier stages of development.
17. *L. atra*.

18. *L. atra*, section of thallus, showing apothecia, *a*, and spermogones, *b*.

19. Ditto, apothecium, magnified.

20. Ditto, spores, young and mature.

21. *L. varia*, ditto.

PLATE XIV.

1. *Lecidea æruginosa.*

2. Ditto, theca and spores.

3. Ditto, free spore.

4. *Lecidea atro-alba*, var. *concentrica* (Leight.).

5. *L. geographica.*

6. Ditto, portion of thallus, magnified, showing dendritiform, black, marginal hypothallus, *a*.

7. Ditto, apothecium magnified.

8. Ditto, section of ditto.

9. Ditto, spore.

10. *Lecidea ferruginea.*

11. Ditto, apothecia, young and old, magnified.

12. Ditto, section of young and old apothecia, showing the concave and convex conditions.

13. Ditto, spore.

14. Ditto, spore acted on by iodine.

15. *L. sanguinaria.*

16. Ditto, section of apothecium, showing the blood-red substratum.

17. *L. sanguinaria*, theca and its protoplasm, bringing only one spore to maturity.

18. Ditto, mature normal spore.

19. Ditto, spores rendered abnormal by adherent, abortive, or rudimentary spores.

20. *L. decipiens;* thallus, magnified, showing the relative position of the spermogones, *b*.

21. Ditto, section of an apothecium, *a*, and of thallus, showing a spermogone, *b*.

22. Ditto, sterigmata and spermatia.

23. *L. granulosa*, var. *decolorans*, spore.

24. *L. punctata*, var. *punctiformis*, spore.

25. *L. quernea;* spores, young and old.

26. *L. pineti*, spore.

27. *L. fusco-lutea*, spore.

PLATE XV.

1. *Opegrapha saxatilis;* section of thallus, showing an apothecium, *a*, and a spermogone, *b*.

2. Ditto, section of a spermogone, showing the sterigmata and spermatia.

3. *O. varia*, var. *notha*.

4. Ditto, lirellæ, magnified.

5. *Graphis pulverulenta*.

6. Ditto, a lirella magnified.

7. Ditto, section of a lirella, showing perithecium or exciple, *a*, and thalamium or nucleus, *b*.

8. *Arthonia Swartziana.*
9. Ditto, ardellæ, magnified.
10. Ditto, section of an ardella.
11. Ditto, spore.
12. *Coniocarpon cinnabarinum.*
13. Ditto, ardellæ, magnified.
14. Ditto, ditto, still more highly magnified.
15. Ditto, section of an ardella.
16. Ditto, spore.
17. *Opegrapha cerebrina,* spore.
18. *Aulacographa elegans,* section of lirella.
19. *Chiographa Lyellii,* section of lirella.
20. Ditto, spore.
21. *Hymenodecton dendriticum,* section of lirella.
22. *Lecanactis lyncea,* ditto.
23. *Opegrapha atra,* ditto.

PLATE XVI.

1. *Sphærophoron coralloides.*
2. Ditto, young apothecium, still closed.
3. Ditto, section of apothecium, showing the floccose-pulverulent thalamium.
4. Ditto, section of young apothecium.
5, 6. Ditto, showing the splitting up of the thalamium in old apothecia. 6 *a.* Section.
7. Ditto, thecæ and spores in different stages of development.

8. *Sphærophoron coralloides*, free spores, some of them destitute of their dark granular epispore.

9. *S. compressum;* extremity of a ramule of thallus showing the spermogones, magnified.

10. Ditto, spermogone.

11. Ditto, spermatia.

12. Ditto, spores, one of them destitute of the epispore.

13. *Calicium hyperellum.*

14. Ditto, stipes and apothecia, magnified.

15. Ditto, spore.

16. *C. turbinatum*, parasitic on the thallus of *Pertusaria communis.*

17. Ditto, section of apothecium.

18. Ditto, thecæ and spores in different stages of development.

19. Ditto, section of spermogone.

PLATE XVII.

1. *Bæomyces roseus.*

2. Ditto, stipes and apothecia, magnified.

3. Ditto, section of apothecium, magnified.

4. Ditto, theca and spores.

5. Ditto, free spore.

6. *B. byssoides*, spore.

7. *Stereocaulon paschale.*

8. Ditto, portion of thallus, magnified.

9. *Stereocaulon paschale*, apothecium, magnified.

10. Ditto, section of ditto.

11. *S. quisquiliare*, nat. size.

12. Ditto, magnified.

13. *S. denudatum*, nat. size.

14. Ditto, extremity of a ramule, magnified.

15. *Lichina pygmæa*, extremities of thalline laciniæ, showing apothecia, *a*, and spermogones, *b*, magnified.

16. Ditto, section of an apothecium and spermogone, magnified.

17. Ditto, thecæ and spores in different stages of development.

18. Ditto, spores in the agglutinated state.

19. Ditto, free spore.

20. *L. confinis*, extremity of a thalline ramule, showing an apothecium, *a*, and several spermogones, *b*.

21. Ditto, section of an apothecium, *a*, and spermogones, *b*.

22. Ditto, spores in the agglutinated state.

23. Ditto, free spore.

PLATE XVIII.

1. *Cladonia rangiferina.*

2. Ditto, sterile nodding apices, showing the spermogones.

3. Ditto, fertile erect apices, showing the apothecia.

4. Ditto, section of a spermogone.

5. *C. pyxidata*, sterile podetia.

6. Ditto, spores.

7. *C. extensa*, apex of fertile podetium, showing the apothecium, *a*, and the spermogones, *b*.

8. Ditto, section of an apothecium and of the fistulous podetium.

9. Ditto, thecæ and paraphyses.

10. Ditto, spores.

11. Ditto, spermogones, magnified, one of them sectioned.

12. Ditto, sterigmata and spermatia.

13. *C. Papillaria*.

14. *C. gracilis*.

15. *C. furcata*.

16. *C. stellata*, var. *uncialis*.

17. Ditto, apices of ramules, magnified.

18. *C. bellidiflora*.

19. Ditto, apothecia and podetium, magnified.

20. *C. deformis*.

21. *C. cervicornis*.

PLATE XIX.

1. *Collema granosum*, sterile thallus.

2. Ditto, portions of thallus, showing apothecia, magnified.

3. Ditto, portion of thallus, showing papulose character of surface, magnified.

4. Ditto, section of apothecium.

5. *C. atro-cæruleum*, var. *lacerum*, sterile thallus.

6. Ditto, portion of sterile thallus, magnified.

7. *C. atro-cæruleum*, var. *lacerum*, portion of fertile thallus, magnified.

8. Ditto, section of an apothecium.

9. Ditto, section of apothecium and thallus.

10. *C. pulposum*, section of spermogone and thallus.

11. Ditto, sterigmata and spermatia.

12. *C. crispum*, var., section of thallus, showing a spermogone, *a*, and a young apothecium, *b*.

13. Ditto, spore germinating.

14. Ditto, spore of another variety.

15. *C. multifidum*, var., *jacobæfolium*, spore.

16. *C. nigrescens*, spore.

PLATE XX.

1. *Endocarpon miniatum*, upper surface.

2. Ditto, under surface.

3. Ditto, magnified, showing papulose condition produced by apothecia.

4. Ditto, spores of var. *umbilicatum*.

5. Ditto, sterigmata and spermatia.

6. Ditto, section of thallus, showing apothecia.—*a*. ostiole.

7. *E. Smaragdulum*, var. *Sinopicum*, thalline squamules, magnified, showing ostioles of apothecia and spermogones.

8. Ditto, section of a squamule, showing an apothecium, *a*, and a spermogone, *b*.

9. Ditto, thecæ, containing an indefinite number of spores.

10. Ditto, isolated spores.

11. Ditto, sterigmata and spermatia.

12. *E. lachneum*, section of thallus and two spermogones.

13. Ditto, spores germinating.

14. Ditto, sterigmata and spermatia.

15. Ditto, free spermatia.

16. *E. sorediatum*, spores full and empty.

17. *Chiodecton albidum*.

18. Ditto, portion of thallus, magnified, showing the relation of the spermogones, *a*, to the apothecia, *b*.

19. Ditto, vertical section of an apothecium.

20. Ditto, transverse ditto.

21. Ditto, section of thallus, showing portion of an apothecium, *a*, and a spermogone, *b*.

22. Ditto, spore.

23. Ditto, spermatia.

PLATE XXI.

1. *Pertusaria communis*, showing zonate condition of young thallus.

2. Ditto, variolarioid degeneration of apothecia.

3. Ditto, apothecial warts, magnified.

4. Ditto, transverse section of ditto.

5. Ditto, vertical section of thallus, showing apothecia.

6. Ditto, thecæ, containing protoplasm or spores in different stages of development.

7. *Pertusaria communis*, theca and spores acted on by iodine.

8. Ditto, transverse section of a theca and spore, showing their thickened walls.

9. Ditto, transverse section of a spore, showing the different coats of the epispore and endospore.

10. Ditto, section of a spermogone.

11. Ditto, sterigmata and spermatia.

12. *Hagenia aggregata.*

13. Ditto, thallus, magnified.

14. Ditto, apothecial warts, more highly magnified.

15. Ditto, section of thallus, showing apothecia with their necked openings, *a*.

16. Ditto, spore.

17. *N. cinerea*, spore.

PLATE XXII.

1. *Verrucaria nitida.*

2. Ditto, portion of thallus, magnified.

3. Ditto, ditto, still more highly magnified, showing relative position of spermogones, *b*, to apothecia, *a*.

4. Ditto, apothecium, magnified.

5. Ditto, section of ditto.

6. Ditto, spores in different stages of development.

7. Ditto, one of the contained cellules of the spore.

8. Ditto, spermatia.

9. *V. gemmata*, section of apothecium.

10. *Thelotrema lepadinum.*

11. Ditto, portion of thallus, magnified.

12. Ditto, section of an apothecium.

13. *Urceolaria scruposa.*

14. Ditto, apothecia, magnified.

15. Ditto, section of an apothecium.

16. Ditto, spore.

17. *U. cinerea*, portions of thallus, magnified, showing relative positions of apothecia, *a*, and spermogones, *b*.

18. Ditto, section of thallus, showing an apothecium, *a*, and a spermogone, *b*.

19. Ditto, section of a spermogone.

20. Ditto, sterigmata and spermatia.

21. Ditto, spore.

22. *Verrucaria alba*, spores in different states of development.

23. *V. epipolæa*, spore.

24. *V. plumbea*, ditto.

25. *V. irrigua*, ditto.

CONTENTS.

PAGE

INTRODUCTION 1

CHAPTER I.

HISTORY OF LICHENOLOGY 18

CHAPTER II.

GENERAL CHARACTERS OF LICHENS, INCLUDING THEIR MORPHOLOGY AND PHYSIOLOGY 32

1. Vegetative System 32

Hypothallus 44

Thallus 32

Gonidia 40

2. Reproductive System 57

a. Apothecia 60

Paraphyses 64

Thecæ 65

Spores 68

PAGE

2. Angiocarpi 287
13. Sphærophoraceæ 287
14. Endocarpaceæ 290
15. Verrucariaceæ 300
16. Limboriaceæ 307

APPENDIX.

BIBLIOGRAPHY:—

1. Morphology and Physiology 76, 319
2. Economical applications 93, 320
3. Geographical distribution 105, 321
4. Classification 31, 119, 319

POPULAR

HISTORY OF LICHENS.

INTRODUCTION.

"God made them all:
And what He deigns to make should ne'er be deem'd
Unworthy of our study and our love."

"Art's finest pencil could but rudely mock
The rich grey Lichens broider'd on a rock."—JANE TAYLOR.

THE purpose of the writer in laying before the public a familiar natural history of British Lichens, is to open up a hitherto neglected, or at least little read, page of the book of Nature; to introduce to those who desire an object to lead them to our coasts or hills, or who require a pursuit combining healthful recreation with scientific interest, a somewhat new, attractive, and fertile field of labour; to

offer to observers in Natural History an opportunity of contributing towards the filling up of a gap, hitherto very conspicuous, in British Botany, as well as towards the further development of the economical resources of our country. The Lichens may be said to be the only family of the *Cryptogamia* which has not met with its due meed of scientific or public attention, and whose natural history has consequently hitherto rested on a most insecure and unsatisfactory foundation. They have ever been the acknowledged *opprobria* of Cryptogamic Botany. The delicate waving frond of the fern is anxiously tended by jewelled fingers in the drawing-rooms of the wealthy and noble; the rhodospermous seaweed finds a place beside the choicest productions of art in the gilt and broidered album; the tiny moss has been the theme of many a gifted poet; and even the despised mushroom has called forth classic works in its praise. But the Lichens, which stain every rock and clothe every tree, which form

> "Nature's livery o'er the globe
> Where'er her wonders range,"

have been almost universally neglected, nay despised. This neglect is to us the more surprising when we consider the facility with which they may be collected, preserved,

and examined even by the humblest observer. The lichenological student requires no cumbrous or expensive apparatus: an old knife and hammer, a few pill-boxes or a tin-case for collecting, a supply of cardboard and paper, with gum or glue for preserving, and a pocket-lens and microscope for examining, constitute his whole *armamentaria*. Nor is it necessary, for the purpose of collecting, to run the risks or suffer the expense of foreign travel: the objects of his search surround him abundantly; from the sea-coast to the mountain summit, he will find them on every tree or rock. Moreover they may be collected at all seasons, in all weathers and climates, at almost all elevations, and in all countries hitherto discovered. But their very familiarity—the very simplicity and inexpensive nature of their study—has doubtless operated in some degree as a cause of this neglect; for many minds are irresistibly attracted by the love of everything that is foreign, while others are fascinated by the possession of complex and expensive apparatus or instruments, which it is beyond the power of the humble observer to purchase. Our own investigations in the forest and on the mountain have too frequently called forth the look of surprise or smile of compassion to permit us to doubt that such studies are popularly

regarded as at best profitless and harmless hobbies; that the collection or examination of "Time-stains" or "Crottles" is considered a wasteful disposal of time and energy. This feeling evidently originates in ignorance of the structural and utilitarian beauties of the family. We shall have occasion in the following pages to show that, in regard to its relative position in the scale of vegetable life, this group of plants, humble and insignificant though it appear to be,—

> "Holds a rank
> Important in the plan of Him who framed
> This scale of beings; holds a rank which, lost,
> Would break the chain and leave behind a gap
> Which Nature's self would rue;"—

that Lichens are of infinite importance as handmaids of Nature in operating her changes on the face of our globe, —in softening down the pointed crags of our mountains,— in covering with fertile soil alike the bare surface of the volcanic lava and the coral islet,—in a word, that they are the basis of soil and consequently of vegetation; that a small section, which furnishes valuable and familiar dyes, gives rise to an import of the annual value of many thousand pounds; that many others, under the vernacular term "Crottle," have been for ages, and still are, used as house-

hold dye-agents by the peasantry in many parts of our country; that in many parts of the world they furnish indispensable food not only to cattle but to man; that they play an important part in the history of Arctic enterprise, inasmuch as they have frequently saved the lives of Arctic travellers; and that they are celebrated in the history of medicine in this and other countries. If, in addition to these high recommendations, we consider that many species have a texture which, by readily imbibing and eagerly retaining moisture, renders them in a sense independent of all climatal changes, enabling them equally to brave polar cold and tropical heat; that many not only cling with such tenacity as to be inseparable from, but can corrode or disintegrate, the hardest and barest rocks, even pure quartz; that the most ample provision has been made by the great Author of all for their reproduction or multiplication, in spite of the most adverse external circumstances, and under conditions fatal to all higher vegetation, both by the multiplicity and abundance of their reproductive cells—which sometimes constitute almost the entire bulk of the plant,—the extremely minute size and delicate nature of these cells, by virtue whereof they are disseminated by every shower or zephyr, and the readiness with which these germinate; and

that throughout the family, both in structure and products, there are many analogies which bind them closely to the *Phanerogamia,* we cannot fail to increase our surprise that a curiosity has not been sooner awakened to become familiar with the natural history of plants which strew the path of man wherever he roams over the wide world,—which constitute the most universally diffused type of terrestrial vegetation. Whether we look upon the Lichens from a scientific or utilitarian point of view; whether we regard the universality of their geographical range,—their beautiful structural adaptations to the position which they occupy in the scale of vegetation, to the part they play in the economy of Nature as the pioneers of vegetable life,—the numerous links in structure and composition which connect them with the *Phanerogamia,*—the importance of their products in our arts and manufactures,—their celebrity in the past history of British and continental medicine,—their connection with the history of Arctic enterprise,—the abundance of nutritive species in the countries and under the conditions of season and climate where they are most required for the sustenance of man and the lower animals,—and the curious combination which they present of essential simplicity of structure with infinite variety of form, we think we have a sufficient

basis whereupon to found our plea for the study of Lichenology. A passing glance would, we are convinced, demonstrate to the most superficial observer,—

"That not alone in trees and flowers
The spirit bright of beauty dwells;
That not alone in lofty bowers
The mighty hand of God is seen;
But more triumphant still in things men count as mean."

One of the most celebrated of recent continental lichenologists, Schærer, has appended to his latest work the following expressive quotation from Cicero:—

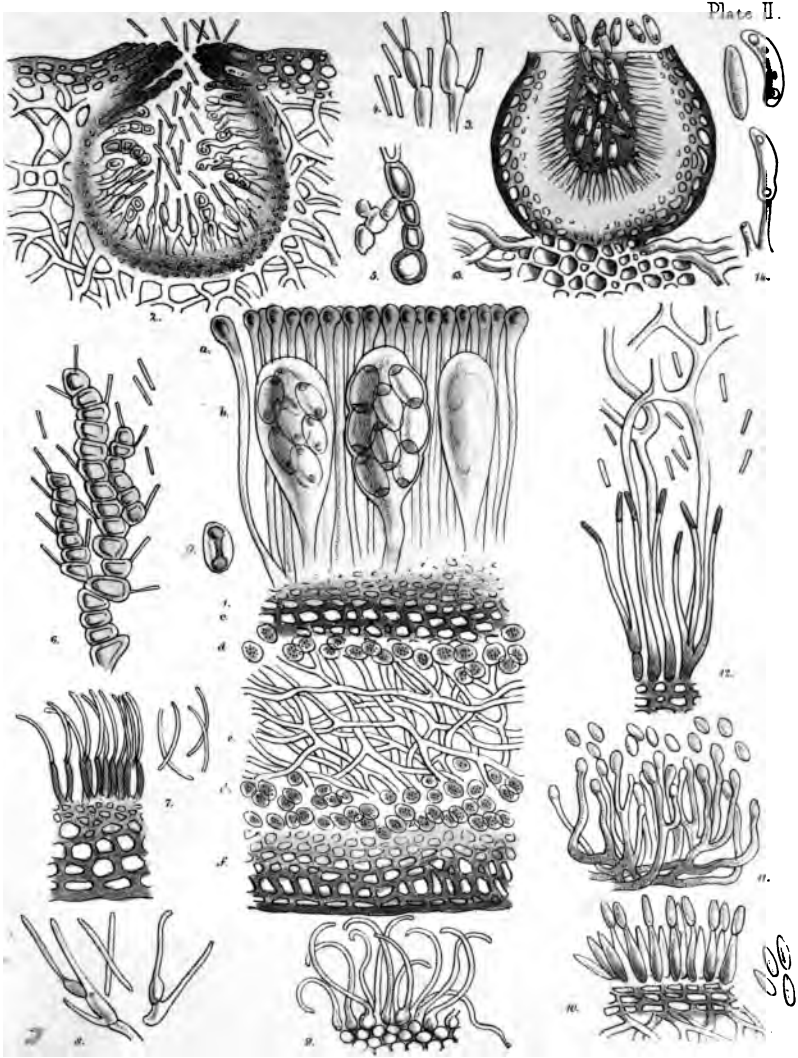
"Hæc studia adolescentiam alunt, senectutem oblectant."

"These studies invigorate youth and solace old-age."

The study of the simplest forms of vegetable organization should naturally form a prelude to, or foundation for, the examination of plants having a more complex structure and higher position in the scale of being. It is moreover eminently calculated to lead to the acquisition of habits of minute observation and patient research,—of an accurate sifting and noting of *facts*,—than which nothing is more valuable, not only to the student of Natural History, but to the educated of all classes of our community. And, lastly, it could scarcely fail to create or intensify a love of the beau-

tiful in Nature,—to furnish important lessons in Natural Theology, by indicating many of the infinite beauties of Creation, and thereby to lead the mind of the observer by imperceptible gradations to "look from Nature up to Nature's God."

There are certain sections of the public upon whose attention in particular we would strongly urge the claims of Lichenology or kindred studies. But in so doing we would have it distinctly understood that it is far from our object or wish to make a special pleading in favour of Lichenology to the exclusion of, or in preference to, other branches of natural history, to which, though in different degree, our remarks equally apply. Let each observer consult his own tastes or opportunities in the selection of a subject. We rejoice to find that a love of natural history is being rapidly and widely created, diffused, and fostered throughout our country; its study is becoming an essential feature in the curriculum of our most elementary schools; its objects are described and its phenomena expounded in all our mechanics' institutes and cognate societies; and by means of the Press its general facts are placed at the command of the humblest of our fellow-workers on the busy stage of life. These proceedings we accept as the exponents of the public tastes and



W.L.Lindsay del.Hitch lith.

Vincent Brooks Imp.

tendencies in regard to natural history; and we firmly believe that these and their resulting attainments require only to be directed into proper channels—to be employed in fertile and remunerative fields,—to be productive ultimately of great good to science.

The following classes of persons, who command the great requirements of time and opportunities, would in particular secure important advantages by familiarizing themselves with such studies as those to which we have alluded:—the invalid from our large towns, whose delicate mental and physical organization have suffered wreck in the too eager or engrossing pursuit of wealth or fame, and who is now compelled for a season to relinquish former habits or studies, and to seek instead the vague objects of change of air and scene in the pure genial atmosphere of the country; the summer lounger at our sea-coasts, whose chief or sole occupation is perchance to listen daily to the mournful and unceasing wail of the "sad sea waves," or to watch the tides alternately leaving and obliterating their footprints on the shifting sands; the *habitué* of our fashionable watering-places, who compels himself daily to drink a certain quantity of mineral water, walk a certain number of miles, and read a certain proportion of a novel, so as to occupy or dis-

sipate his time; the tourist among our Highlands and Islands, whose chief aim is too frequently to pass over the greatest amount of space in the shortest possible time, and who too seldom merges from the beaten track laid down in his favourite guide-book; the Art student in search of the picturesque among our hills and vales, who cannot truly appreciate the picturesque without being acquainted with the minutest elements of which it is composed; and the fair denizen of our urban drawing-rooms, whose accomplishments, gained it may be at a great expense of time and money, are too frequently frivolous and profitless, and who have, more than any class of persons above mentioned, the necessary time and qualifications. By following out any branch of natural history, the invalid finds a new charm in every walk; he feels that he can profitably employ, without mental or bodily fatigue, even the idleness which illness has thrust upon him, by acquainting himself with the characters of the lowliest yet not least interesting, organisms in the scale of vegetable or animal life. It may not be supererogatory here to remind the reader of the well-acknowledged influence over the human mind of gently-exciting studies as moral medicines of the most soothing, and intellectual food of the most nourishing, kind. We would commend the invalid—

"To pace
The forest's ample round,
And see the spangled branches shine,
And mark the *moss* of many a hue
That varies the old tree's brown bark
Or o'er the grey stone spreads."

Let him try our recipe; let him look upon nature with the eye of a naturalist, and let him communicate his impressions to his brethren in affliction. Were he to subject himself to such a course of mental and physical hygiene, we place his physician and all the potency of the *materia medica* at defiance. The lounger at our sea-coast bathing-places would experience a new delight in his scrambles among the cliffs, were he acquainted with the character or uses of the lichens which crust their surface with a grey or yellow coat, for littoral or marine species are possessed of additional interest from the circumstance that they include the most valuable tinctorial species,—whose products are the bases of the Orchil, Cudbear, and Litmus, so familiar to the dyer and chemist. The tourist, merely in search of fresh air and exercise, or of that equally vague entity denominated scenery, clambers upwards of three thousand feet to the summit of Ben Lomond or Ben Nevis, for the purpose of catching a glimpse of sunrise or sunset, or of viewing a certain number of

counties,—mountains, rivers, lakes,—spread like a carpet at his feet. But his hopes in the majority of cases are too likely to prove delusive: he probably sees nothing but "mists on the brae," for every traveller in the Scotch Highlands knows full well how apt he is to be disappointed in his expectations by the mists and storms of its moist and treacherous climate. To him the black heaths, time-stained boulders, and bristling crags are only so many obstacles to the attainment of his aim. Instead of beauty, he finds only desolation in the scene; and under a sense of disappointment, overcome by a feeling of loneliness and gloom, he is perhaps too prone to have recourse to artificial stimulants of a questionable character. But under the same circumstances, the naturalist requires no other stimulus than the sight of the natural objects which encompass and strew his path. *His* eye never dims,—his energies never flag,—his spirit never wearies, so long as he can find, on every rock or tree,

> "Ten thousand forms minute
> Of velvet moss or lichen, torn from rock
> Or rifted oak."

He looks upon every mis-shapen boulder as a treasury of Lecanoras, Lecideas, and Umbilicarias; in each he reads valuable lessons on the characters and geographical range of Lichens; he may be said literally to find "sermons in

stones." In the rock-clefts and gullies of our Highland mountains he finds,

> "Cabined and confined
> At once from sun and dew and wind,"

various Lecideas and Cladonias; and even on the naked rocks of their cloud-capped summits, where there is an almost total deficiency of a higher vegetation, luxuriating

> "Amidst the war of elements,
> The wreck of matter and the crash of worlds,"

he meets with the curious and valuable black leathery Umbilicarias. Should the mists obscure his view, they do not damp his spirits; he atones for his disappointment by filling his vasculum, and adding to his stock of knowledge a new store of observations. The Art student, in his professional tours among the scenic beauties of our country, would also look in a different light on every mossy tree, crusted crag, or time-stained battlement; he would be led to paint Nature from a higher and holier view-point. To the fair sex especially, during their summer search after health and happiness, we would commend the study of Natural History as infinitely more ennobling than the host of fashionable though profitless accomplishments, which they at present take such pains to possess. Many ladies have already taken a high stand as Algologists and Pteridologists; many have cultivated

the physical sciences, with such success as may well encourage others to follow their example: they are by nature better fitted than men to collect and preserve minute and delicate organisms; and we see no reason why they should not be equally capable of examining and describing, did they direct their energies or acumen in this direction. The Poet too, whose highest aspiration ought to be to describe Nature, and who frequently borrows his imagery from the beauties of creation, ought to be well acquainted with at least the general features of Natural History. An ignorance of this subject however is too often, we fear, betrayed in his productions. As a humble illustration bearing on our present subject, the poet Gray speaks of the

"Rude and moss-grown *beech*;"

while any tyro in Lichenology might have taught him the inappropriateness of such an expression, for the bark of this tree remains comparatively smooth, although it is liable to separate, as its age increases, in annular masses; and it is habited by *Graphideæ* and *Lecideæ*, while it is seldom or never the habitat of the Ramalinas, Usneas, Physcias, or Cornicularias, which constitute the familiar "beard" or "moss" of aged trees. We have often regretted the many valuable opportunities annually lost of improving our knowledge of natural history in general, and certain branches thereof, of

which Lichenology forms one, in particular; while we are satisfied that the idler, professional or amateur, voluntary or non-voluntary, could not find a more pleasant as well as profitable means of dissipating *ennui*, and occupying a leisure that must at times lie heavy on his hands. Nay, we may go still further, and recommend it as a delightful relaxation in the intervals of business or more severe study: in our own experience we have found it so. Let it not be supposed that we can recommend these pursuits merely as forms of intellectual gratification to the individual engaged in them; they are capable of a more extended influence and application. We believe that every observer, however humble his sphere, and however meagre his opportunities, has it in his power to contribute materially to the progress of science, and to the development of its economical or practical applications, by the simple noting of matters of *fact*. No group of plants is more Protean in its characters than that of the Lichens,—none more subject to structural alterations under the influence of external circumstances. Hence the investigation of the innumerable phases or forms under which species may occur—and without an accurate knowledge of which all classification must be unsatisfactory and temporary—is a labour of almost insuperable difficulty to an in-

dividual; while it becomes one of comparative ease to a multitude of observers, working towards a common end under different conditions of climate and country. In no section of botany therefore are the labours of individual collectors or investigators, on however small a scale, more likely to contribute to a higher *status* of the science, or a more accurate knowledge of the natural history of the plants composing it, than in that of Lichenology. The paucity of labourers in this field,—the deficiency of corroborated and multiplied observations common to all countries and climes, have been one great cause of the obscurity which has hitherto enveloped the subject of Lichenology. Should this little Work induce any labourers to enter either upon the comparatively circumscribed, but also comparatively unworked, though promising, field of Lichenology, or the broader and more attractive region of general Natural History, its purpose will have been fully answered.

Within the limits of a popular treatise we feel it impossible to do justice to a subject of such novelty and extent as the Natural History of British Lichens. We can only enumerate the general characters of the more common and better known species, which beginners in the study of Lichenology are most likely to meet in their country rambles.

By confining ourselves to the description of typical or common species, and by means of introductory chapters devoted to the consideration of their external characters, internal structure, uses, distribution, and classification, we hope to be enabled to lay before the general reader, or the young student of Nature, a comparatively complete, though concise, view or account of the principal features of their natural history. Experience of the difficulty of procuring information upon, or access to lichenological literature has induced us to append, in foot-notes to the several chapters, references to the works most worthy of consultation for fuller details than are hereinafter contained. The addition of these references may, we trust, serve to render the Work not unacceptable to the more advanced student of botany or natural history, as a familiar introduction to the study of native Lichens; and may enable those who are desirous of dipping more deeply into the study of Lichenology than they can do in the pages of a popular treatise, to prosecute the subject according to their time or inclinations.

"Not a plant, a leaf, a flower but contains
A folio volume. We may read, and read,
And read again, and still find something new,—
Something to please,—something to instruct,—
Even in the noisome weed."

CHAPTER I.

HISTORY OF LICHENOLOGY.

"Let me suggest that the study of the simple plants ought to take the precedence of those whose organization is more complex and intricate, as being the simplest expression of the laws of vegetable life."—COULTAS.

THE dark and almost impenetrable veil which has for ages enveloped the subject of Lichenology,—and especially the question of the reproduction of Lichens,—has not been due to the deficiency or absence of a special literature. On the contrary, the Lichens, like the *Salices* and *Hieracia*, may be said in a manner to have been "rendered botanically odious by books." In the works of the earlier Lichenologists,—who did not possess suitable instruments for research,—the microscope in particular having been rendered available in botanical science only within a comparatively

recent period,—*speculation* to a great extent took the place of *fact*; there was profitless straining after analogies which did not really exist,—a bending of fact to the subservience of theory. Observations were imperfectly made, or were coloured and perverted by the dominant idea. Fruitless discussions were entered into on the reproductive functions, based on erroneous or imperfect data: each author built up a new classification and devised a new nomenclature. As a necessary consequence, genera and species have been in a constant state of transition, both as regards name and position in classification. Some Lichenologists, whose dominant tendency has been the splitting up of species, and the devising of new names, have been constantly creating new subdivisions of the family, new genera, new species, and new varieties, thus adding materially to the complexity of nomenclature and classification; others, whose minds led them to generalize, have, on the other hand, been as actively employed in fusing together or combining certain genera and destroying others, thus contributing towards a simplification of the natural history of the Lichens. Such a condition of Lichenology could not fail to render its study both difficult and repulsive to the general student of natural science; —hence one great cause, undoubtedly, of the obscurity in

which it has hitherto remained, of the neglect which it has hitherto suffered. Instead of advancing science, the labours of earlier Lichenologists more frequently constituted barriers to its progress, for later authors have been chiefly occupied in correcting the errors, supplying the omissions, and clearing from the field the

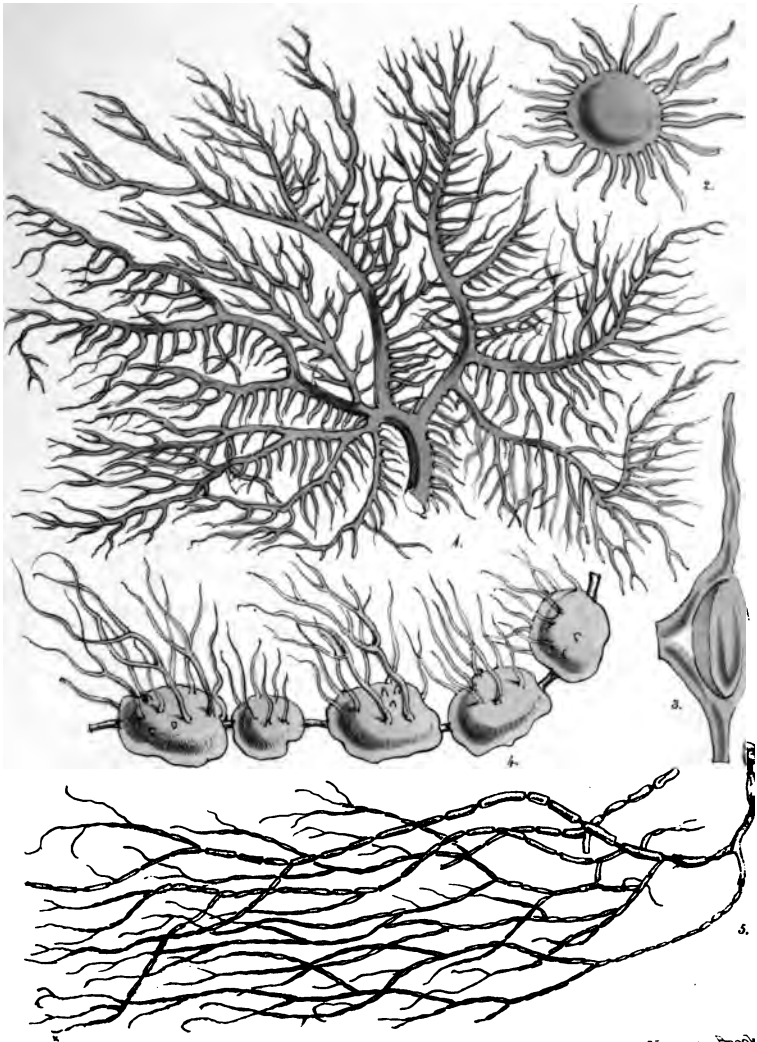
"Rudis indigestaque moles"

of crude theories accumulated by their predecessors. Thus, though much has been written, little real progress has been made until within a comparatively recent period. We may now be said to be entering on a new era in Lichenology; it is now being studied in a more philosophic spirit, and with all the aids which modern discoveries in science—which the microscope and chemistry—can furnish. Facts are being earnestly and patiently sought after; generalization and theory avoided until a sufficiency of data be accumulated to form a firm foundation for the superstructure of classification; and a determination is being evinced to overcome all the obstacles and difficulties which naturally beset a subject which has been rendered so intricate, and which is now being stormed as a fortress that has successfully withstood the repeated assaults of scientific observers; and moreover we believe the labourers are increasing and

volunteers are coming forward who esteem it an honour to join this forlorn hope of Cryptogamic Botany, who are eager for the work solely on account of its difficulty. In proportion as the Lichens are more fully studied by the reflected light of modern science,—and especially in proportion as their various forms or phases, produced or modified by variations in external circumstances, are carefully examined in different countries and under different climes,—so will the study of Lichenology become more simple and attractive. It will not suffice to collate the characters of species contained in the musty folios of celebrated Herbaria; nor is it enough to apply the microscope and chemical reagents to the examination of old and dried specimens. Of observers of this class we have had enough. But the labours of the student must equally begin and terminate on the spot where the Lichens grow; his herbarium and book of reference must be the hill, the heath, the forest; there he must watch patiently and note accurately—it may be for a series of years—the stages of origin, growth, and decay of species under all the influences, terrestrial and aerial, by which these are so liable to be affected.

Several Lichens were probably known to the ancients as furnishing valuable purple dyes, and appear to be alluded

to under various names in the works of Dioscorides, Theophrastus, and Pliny; but they do not appear to have attracted much scientific attention, or to have become the subjects of special classification till about the beginning of the seventeenth century. The ideas of the earlier authors, even for a considerable time subsequent to this period, regarding their nature and position in the scale of vegetation, were of a very primitive and erroneous kind. Many species were believed to be accidental or anomalous productions, developed according to no known law,—growing under conditions inimical to all other vegetation: hence the theory of equivocal or spontaneous generation was advanced in explanation of their origin and growth. One phasis of this theory appeared in the doctrine that, according to the external circumstances by which they are surrounded in germination or genesis,—according as the medium in which they arise and vegetate is earth, water, or decaying organic matter,—certain vegetable cellules become Lichens, Algæ, or Fungi; nay, some authors have even gone the length of asserting, that under certain circumstances they are transmutable into animalcules! Another phase assumed the form of a belief that the decomposition of organic bodies gives origin to organic bodies lower in the scale of being,



W.L. Lindsay del. Fitch lith.

Vincent Brooks

and that the Lichens are merely the result of the decomposition of a higher vegetation. Such ideas, which may be regarded as foreshadows of, or as analogous to, the progressive-development theories of more modern times, however ingenious in themselves and attractive from their apparent simplicity, could not for a moment stand the test of experience. They originated in, and were fostered by, the speculative dispositions of the German school of observers. Sprengel, who very beautifully designates the *Cryptogamia* as the "secret recesses of Nature's sanctuary," speaks of many of the Lichens as "formed of nothing but pure precipitation from the vegetable juices, except here and there some slight rudiments of a cellular organization."

In reviewing briefly the onward progress or history of Lichenology in Europe, we may regard it as divisible into three eras, the first dating about the year 1700, and marked by the labours of Tournefort; the second occurring about the year 1800, and characterized by the voluminous and valuable works of Acharius; and the third commencing about 1850, and distinguished by the important monograph of Tulasne. Prior to the date of the first era above alluded to, the Lichens were included indiscriminately, under various names, among Mosses or Fungi. By Tournefort, in his 'In-

stitutiones Rei Herbariæ,' they were for the first time collected into a separate group, to which he gave the term *Lichen*. This term, though its derivation has been given variously by different authors, is probably derived from the Greek word λειχην, *leichen* or *lichen*, a wart, which the fructification of this group of plants frequently resembles. This group, or family, Lichen, did not however include all the genera or species of the family as now known; certain of them, having a rigid or somewhat coral-like consistence or appearance, he dissociated under the name *Coralloides*, a group in which he included also some sections of the Fungus or Mushroom family. About forty years subsequently Dillenius, in his classic 'Historia Muscorum,' further subdivided the family by constituting his sections *Usnea*, *Coralloides*, and *Lichenoides*; with these however were associated certain sections of cognate cryptogamic families, in this case the *Hepaticæ* and *Confervæ*. The illustrious Linnæus preferred embracing all the Lichens under a single genus, *Lichen*, which he however subdivided into eight sections, according to the characters of the vegetative system, or thallus. Upon the latter, up to this period, Lichenologists had based their classification and nomenclature; but Hedwig and Gærtner, whose works are next in order of date, carefully examined

the fructification of Lichens, and upon their characters, real or supposed, they based rival theories of their reproduction. This subject has been, until within the last few years, the *pons asinorum* of Lichenologists, and without suitable means of research, it could not fail to be a botanical problem of insuperable difficulty. The absence of fact, however, did not prevent the development of theory; and for a considerable period there raged in the botanical world a discussionary war as to the most probable physiology of reproduction in Lichens. One faction of disputants, whose motto was probably "*omne vivum ex ovo*," and who believed with Linnæus,

> "Vegetabile omne flore et fructu instruitur,
> at nulla species bis destituta,"

contended, on the ground of analogy, for the necessary sexuality of organs; and various authors endowed various bodies, seated on the surface of the *thallus*, with the male or complementary functions. The opposite faction, on the ground of observation, denied the proof of the existence of either male or female organs of any kind, and asserted that Lichens were invariably propagated by means of isolated cellules which were analagous, in regard to function, to the buds, or *propagos* (offshoots) of the higher plants. Between

these extreme views, numerous theories were from time to time advanced to account for their discrepancies, or supply their omissions; but they were all equally characterized by one circumstance, which completely invalidated their stability, viz. that they were unsupported by, or inconsistent with *fact*. According to the views taken by observers of the relative importance of the vegetative or reproductive organs, systems of classification were based on the characters of the thallus or apothecia; and as a result in either case, they were unnatural and artificial. By earlier Lichenologists, the characters of the thallus alone were taken as a basis of classification; by their immediate successors, those of the apothecia; but later observers have discovered that their only safe rule of guidance is

"In medio tutissimus ibis."

By taking the characters of the thallus as a base, we are compelled to group together Lichens having the most opposite fructification; while by assuming those of the apothecium we place side by side species possessed of the most dissimilar vegetative systems: in either case the harmony of nature is offended by the unnatural combination. It is only by regarding together the vegetative and reproductive systems,—their minute or microscopic anatomy, as well as their

general or external characters, physical and chemical,—that we can hope to succeed in founding a natural system of classification, consisting of a chain of natural groupings or small families, not only more or less closely allied to each other but to other Cryptogamic families, especially the Algæ on the one hand and Fungi on the other. Such a system has hitherto been a desideratum in Lichenology, a want which could not, until the invention of the microscope, have been supplied; such a system has not yet been attained, though the labours of recent investigators in Germany, France, and England, have contributed much in this direction. One of the first attempts at a natural system, composed of Natural Orders or sections, was made by Hoffmann at Göttingen, towards the close of the era which we have been describing. The advent of the second era was marked by the works of a distinguished Swede, Eric Acharius, works which gave an impetus to the study of Lichenology, and which have, to a greater or less extent, formed the basis of all subsequent lichenological literature. But these works were too much mere systems of classification,—mere catalogues of names and lists of specific characters: there is a deficiency of information regarding minute anatomy. The same remark is applicable to the 'Lichenographia Europæa Reformata' of Fries

[of date 1831], and the 'Enumeratio Critica Lichenum Europæorum' of Schærer [published so lately as 1850],—the most valuable works for a description of European Genera and Species to which we can refer the student. It is only within the last few years that the minute anatomy and physico-chemical characters of the vegetative and reproductive cell-systems of the Lichens have attracted the attention of botanical microscopists. In Germany, a host of monographers, such as Itzigsohn, Bayrhoffer, Rabenhorst, Von Flotow, and Von Holle; in France, Tulasne and Montagne; in Russia, Buhse; and in England Leighton, have recently published valuable contributions to this branch of Lichenology,—contributions which have placed the Lichens, in point of anatomy and physiology, on at least an equal footing with other Cryptogamic families, to which they have hitherto been considered far inferior in the scale of vegetation. But the most important monograph ever published on this subject is unquestionably that of Tulasne,—his 'Mémoire pour servir à l'Histoire Organographique et Physiologique des Lichens,' published in the 'Annales des Sciences Naturelles,' in 1852. This author apparently sets at rest the long debated question of the reproduction of Lichens, by describing the minute anatomy of organs which must now be generally con-

sidered to be endowed with a function complementary to that of the *apothecia*, or female organs, so long familiar to Lichenologists. Considerable facility has likewise been given of late years to the study of Lichenology by the publication of fasciculi of dried species, classified and named, by Desmazières in France, Schærer in Switzerland, Fries in Sweden, Flœrke, Flotow, Zwack, and others, in Germany, Massolongo in Italy, Leighton and Bohler in Britain.

Lichenology has never found much favour in Britain; comparatively few monographs have been devoted to the subject—more particularly to the minute anatomy of native species—and the descriptions and arrangement of British Lichens, to be found in several general or special floras of our country, are based on those laid down by Acharius fifty years ago. The chief works to which reference may be made for descriptions of British species are the classic 'English Botany' of Sowerby, originally published a century ago, which contains figures and short descriptions of the greater number of British Lichens, arranged however without any system; the elaborate but fragmentary and unfinished 'Lichenographia Britannica' of Turner and Borrer; the 'English Flora' of Sir J. E. Smith; the 'Flora Scotica' of Sir W. Hooker; the 'Flora Scotica' of Light-

foot; the 'Flora Edinensis' of Greville, one of the first of British cryptogamists; the 'Flora Hibernica' of Mackay; and the monographs on the British Angiocarpous Lichens and on the British *Graphideæ*, lately published by Leighton. The works of the latter author have the merit of being the first British works to contain descriptions of the spores of native species; his monograph on the *Angiocarpi* is indeed based upon or "elucidated by their sporidia." The ground has thus been broken in Britain for a more philosophic study of Lichenology than heretofore; but much remains to be accomplished,—the field is open, the harvest promises to be bountiful. Nor must we here omit to mention the labours of our *facilè botanicorum princeps*, Robert Brown, in the description of Arctic species collected in the voyages of Parry and Scoresby; or of Churchill Babington in the lichenographical department of the magnificent floras of New Zealand, the Antarctic regions, etc., recently published by Dr. J. D. Hooker, the distinguished son of a distinguished sire. North American Lichens have been described by Halsey, Torrey, and Tuckerman; those of Chili by Nylander; those of Brazil by Eschweiler; and the collection and description of species from other and more distant parts of the world, within the last few years, serve to corroborate

the belief and justify the anticipation that the present era of Lichenology is much more promising of valuable results to Botanical Science than any of its predecessors.

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CHAPTER II.

GENERAL CHARACTERS OF BRITISH LICHENS.

"Some are reddish, some brown, some grey, and some black,
And they're puckered, edged, button'd, or fringed, front and back:
Some are lying like leather close under your feet,
Some waving from trees in the forest you 'll meet."—MISS TWAMLEY.

WE shall here consider the minute or microscopic anatomy, as well as the ordinary physical and chemical characters of the vegetative and reproductive systems of Lichens, and shall also review generally the biology of a Lichen, tracing the various phases of its existence from its origin to its decay.

The term *Thallus* (θαλλὸς, a *frond* or *green leaf*,) is generally employed to designate the vegetative system or mass of nutritive organs of a Lichen. Though bearing no structural resemblance to either, it may be considered as combining the offices and supplying the place among the Lichens of the stem, root, and leaves of the higher plants. In *form*

it is typically *horizontal* or *vertical*, according to the intimacy of its adhesion to its base of support, and the direction and mode of development of its constituent cells. The subdivisions or modifications of the *horizontal*, or typically adherent, thallus, are the *crustaceous* and the *foliaceous*, or *frondose*. The crustaceous thallus forms a mere crust or coating, of varying thickness, on its base of support. When comparatively thick, dense, and hard, it is denominated *tartareous*, as in many Lecanoras; this form is frequently whitish or pale-coloured, chalk-like, friable, and rough or warted on its surface. As constituent elements, it often contains a considerable amount of mineral matter, such as the carbonate and oxalate of lime, besides colorific principles capable of yielding valuable purple pigments; hence many Lichens having this form of thallus are used in the arts. Species with a tartareous thallus most frequently grow on rocks, to which they adhere by their whole under surface so intimately as to be inseparable therefrom; there appears to be a corrosion or disintegration, and subsequent firm union by and between the Lichen and the surface of the rock, which is sometimes the hardest and purest quartz. From the nature of its habitat, the tartareous Lichen is one of the most common forms of its family, growing on

the bare and weather-beaten rocky summits of our highest mountains. When of greater tenuity—forming a scale-like expansion on the surface of rocks or the bark of trees, as in many Lecanoras and Lecideas—the crustaceous thallus is denominated *leprose*. Leprose species are also exceedingly common from our sea-coasts to our mountain summits; but they are much less valuable in the arts. When the crustaceous thallus occurs in its greatest degree of simplification,—when its constituent cellules exist in a very loose state of aggregation, forming a mere powdery coating, of varied colour, on a rock or tree, it is designated *pulverulent*. This is the simplest form under which lichenose vegetation occurs; it is the rudimentary condition of many species, and the abnormal or abortive form of others, depending upon or produced by an absence of the external conditions necessary or favourable to development. By the older lichenologists its true nature was not understood; and Lichens having this form of thallus were by them constituted into a distinct genus, under the name of *Lepra* or *Lepraria*, the species being chiefly named according to their colour, such as *L. nigra, alba, flava, chlorina*, the black, white, yellow, or green *Lepraria*. This form of thallus may be examined by the student in any wood, on the moist rotten

stumps of dead trees, or in any glen, in damp, shady fissures of rocks. It must however be distinguished from a pulverulent condition of the surface of the thallus, which occurs in many foliaceous species. The crustaceous thallus may be *effuse*, that is, of no determinate shape, and with no visible limits or border, which is gradually lost on the surface of the base of support; or *uniform*, that is, of definite shape and with a distinct margin. It is denominated *effigurate* when its circumference assumes a radiate or irregularly stellate appearance; and *squamulose* or *imbricate* when its peripheral segments, or *laciniæ*, assume a foliaceous character, and are arranged in a scale-like or house-tile-like manner.

The *foliaceous* or *frondose* thallus is a flattened, leaf-like expansion, whose texture or consistence, according to its thickness and the arrangement of its cellular tissue, is *membranaceous*, *coriaceous*, or *cartilaginous*, and whose margins are divided into segments, which, according to their size, are denominated *lobes* or *laciniæ*, the former being typically broadish and rounded, the latter narrow and linear. Foliaceous Lichens include the largest and most brilliantly coloured species, such as those of the genera *Parmelia*, *Peltigera*, and *Sticta*. Their geographical dis-

tribution is the opposite of that of crustaceous species, attaining their maximum development at low altitudes and in tropical countries. Their habitat is most frequently the bark of trees or the ground. Some species adhere to bases of support by numerous minute fibrils or bundles of filaments, proceeding from the under surface of the thallus; these are denominated *rhizinæ* or *fixuræ*. They resemble rootlets in appearance, but not in function, acting chiefly, if not solely, as means of adhesion. In some species growing on moss they are long, pale-coloured, and delicate, as in *Peltigera;* in others, inhabiting the bark of trees, they are very short, filiform, and black. In some foliaceous Lichens there is a single and frequently central point of adhesion, by means of a kind of disc or sucker. The crustaceous and foliaceous thallus exhibit many intergradations and combinations, which give rise to an infinity of irregular forms.

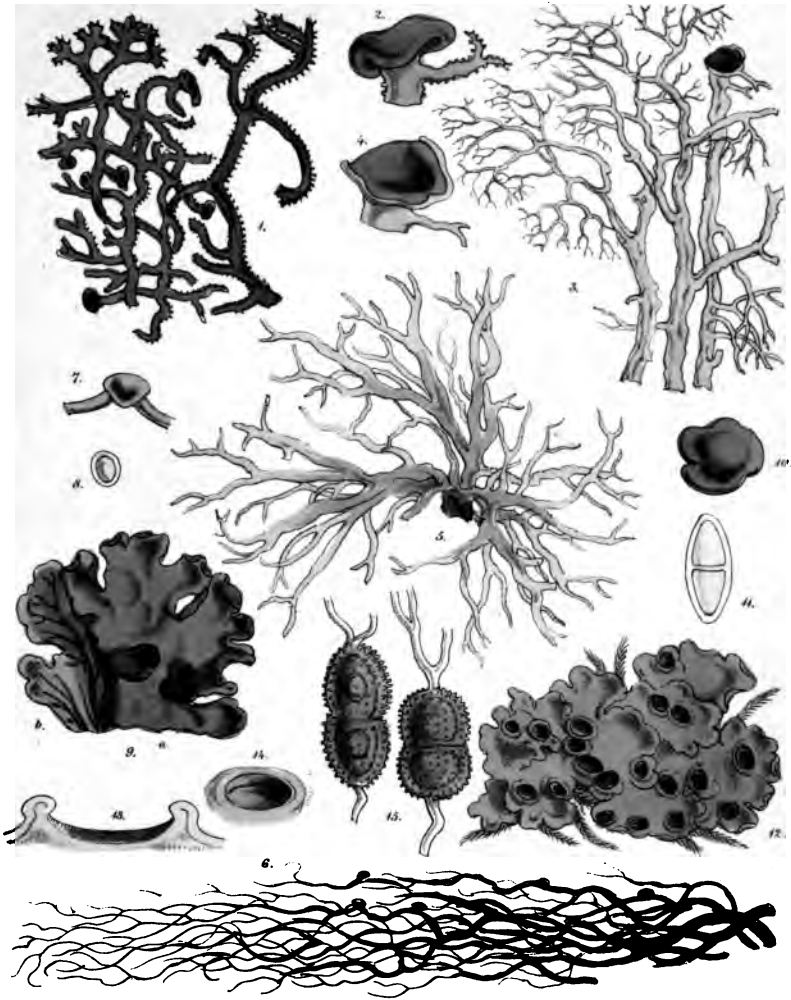
The chief subdivisions of the *vertical*, or typically free, thallus, are the *fruticulose* and *filamentous*. The former consists of a shrub-like mass or aggregation of rigid, erect, narrow, simple or branched, stem-like segments, which sometimes arise from a common disc-like base, as in *Sphærophoron*,—sometimes spring separately from a small foliaceous or crustaceous horizontal thallus, as in some *Cladonias*

and *Stereocaulon*. These branch- or stem-like developments of, or prolongations upward from, the thallus may be solid or hollow. In the latter case they are frequently cylindrical, and dilated at their apices into cup or funnel-shaped cavities, the margins of which bear the fructification. Such a body may be regarded as a secondary or vertical thallus, developed from the cortical substance of a primary, small, horizontal thallus; it is designated a *podetium* (πούς, Gr., *pes*, Lat., a foot), and is characteristic of the Cladonias. On this podetium there is frequently to be found a tertiary or second horizontal thallus, growing from its surface more or less abundantly in the form of minute foliaceous squamules. Fruticulose Lichens include some of the most valuable dye-species, as the *Roccellæ;* and some of the commonest species growing on our forest-trees, as the genus *Ramalina*,—on our heaths, as the genus *Cladonia*,—and on our hills, as the genera *Sphærophoron* and *Stereocaulon*.

The *filamentous* thallus likewise forms a shrub-like mass consisting of flaccid, or somewhat rigid, round, thread-like, or filamentous segments,—sometimes, and especially in the young state, growing erect, more frequently pendulous, and even occasionally prostrate, such as the genus *Usnea* and some species of *Cornicularia*. Filamentous Lichens are

chiefly confined to, and form a characteristic coating of, the older trees of our forests, which thus become "mossed with age." In appearance they most closely approximate the characters of higher plants. Some species appear possessed of a distinct stem or axis with numerous divergent branches: but these have none of the structural characters of the stems or branches of the *Phanerogamia*, or Flowering Plants; they are wholly cellular. Filamentous species are comparatively limited in geographical range, and are chiefly found at low altitudes; they are susceptible of few economical applications. As the crustaceous and foliaceous, so the fruticulose and filamentous thallus are closely allied. All these forms pass into each other by insensible gradations, giving rise to great irregularities in the character of the thallus of Lichens. Filamentous species are usually adherent to bases of support by means of a central point.

If we tear or cut across any common foliaceous or fruticulose species, we shall find it, by the naked eye, to consist of three distinct tissues, viz. superiorly or externally of a tough, membranaceous or leathery, impervious, dense *cortical* layer; immediately subjacent or internal to this, of a thin, bright-green, *gonidic* layer; and inferiorly or inter-



W.L.Lindsay del. Fitch lith.

Vincent Brooks Imp.

nally, of a white, cottony, spongy, *medullary* layer. The assistance of the microscope will enable us to determine that the cortical tissue consists of a closely aggregated series of thick-walled, typically spherical cells, but which have assumed various irregularities of shape from pressure and abortion; that the gonidic layer is composed of a series of globular cells in a very loose state of aggregation, both with each other and with the tissues with which they are in relation, and which contain a greater or less quantity of bright-green chlorophyll, either in the form of distinct granules, or of an amorphous, semi-fluid matter; and that the medullary layer is composed of a somewhat loose network of branching tubes or filaments delicate or thick-walled, simple or marked by internal septa, which indicate their constituent cells, and which may be empty or filled with a transparent gummy matter: the interstices of this medullary network contain air. A large-celled, thick-walled, coarse medullary tissue may be easily studied in the *Peltigereæ*. Bundles of these filaments are frequently developed downwards in the form of the *rhizinæ* or *fixuræ* already alluded to. The whole tissues of the Lichen-thallus are thus seen to consist of modifications of two forms of simple cell,—the spherical or rounded, which by pressure becomes hexagonal,

polygonal, oblong, or irregular in different species; and the cylindrical or elongated cell, by the disappearance of whose septa, when in apposition to other cells, the tube or filament is produced. These medullary tubes, though bearing a general resemblance, have no functional affinity to the vascular tissue of the *Phanerogamia:* they are not vessels or canals for the conveyance of sap, though they imbibe and convey water with great readiness and rapidity. The walls of both forms of cell above-mentioned are composed of *cellulose*, a non-nitrogenous substance resembling starch; and Payen remarks that the cell-wall in Lichens differs from the thick sclerogenous cell-wall of the seed of the *Phytelephas*, or Ivory Palm, merely in its superior thinness. Between the individual cells in the various tissues there is an intercellular matter of a gummy nature, which is supposed by some authors to be an excretion of, or product thrown out by, these cells.

Of all the cell-forms above described, the most important are the isolated cellules of the sub-cortical or gonidic layer, which are denominated *Gonidia* (γόνη, *generation*, and εἶδος, *resemblance*, probably so called from their functional resemblance to the spores*). From the important part they

* Vide Körber 'De Gonidiis Lichenum;' and also in the 'Annales des

play in the multiplication and modification of the Lichen-thallus, they demand more than a passing allusion. They may be regarded as intermediate in function between the vegetative and reproductive cell, assuming the offices and partaking of the characters of both; but as they are peculiar to, and characteristic of, the thallus of Lichens,—serving to distinguish them from cognate families,—and as their hypertrophic or abnormal condition is one chief cause of irregularity in the external characters of the thallus, we prefer considering them here. Their great peculiarity, we have already incidentally stated, is the want of union between each other and between them and surrounding tissues. They play an important part in the development of the young thallus, and are the main element frequently in the pulverulent form of the crustaceous thallus formerly alluded to. They frequently burst through the cortical layer of a Lichen, appearing on its surface in the form of powdery masses, varying in size and colour, denominated *soredia*. In the foliaceous thallus, on which they are commonly met

Sciences Naturelles,' Second Series, 1840, and the 'Flora,' 1841; papers by Thwaites and Dickie in 'Annals of Natural History,' formerly the 'Magazine of Zoology and Botany,' vols. iii. and viii.: Cassini in his 'Opusc. Phytol.' 1826; 'Botanical Gazette' (Müller), April, 1849 (Thwaites), April, 1848, March, 1849, July, 1850.

with, they usually appear first towards the centre, sometimes extending centrifugally over its whole surface, so as to give it a general pulverulent appearance; sometimes they are developed at the extremities of the thalline lobules, or *laciniæ*, as in *Parmelia ceratophylla*, var. *physodes*; sometimes they occur in orbicular or globular masses, sprinkled over a fruticulose thallus, as in *Ramalina farinacea*. Scattered sparingly over the surface of a thallus or apothecium, they give it a pruinose or frosted, farinose or mealy appearance, according to their quantity and colour. The disc of an apothecium is sometimes rendered abortive by sorediiferous degeneration; the soredia then become discoid or globular, assuming the form of the abortive apothecium. This is the basis of the old genus *Variolaria*, which is now found to be merely an abnormal condition of the thallus or its fructification, depending on a hypertrophy, or excessive development, of the gonidic element. This variolarioid condition is not uncommon in many crustaceous species, as those of the genera *Pertusaria* and *Lecanora*. On the under surface of the thallus of the genus *Sticta*, soredia occur in the form of minute urn or cup-shaped bodies, called *Cyphellæ*, which appear to be excavated in its substance,—sometimes white, more frequently yellow or greenish; on the upper surface

of the thallus, in the same genus, soredia occur in their usual form, frequently of a bright yellow colour. These cyphellæ are originally globular or wart-like, and become urceolate, or cup-shaped, only on expanding. With age the soredia sometimes fall out, leaving the cavity empty. In other species gonidia are developed on the surface of the thallus in the form of granules or very minute wartlets, producing the condition termed *furfuraceous;* or in the form of folioles or squamules, constituting that called *squamulose.* The former condition occurs in *Physcia furfuracea,* and frequently in *Parmelia saxatilis;* the latter in many *Cladoniæ.* On the surface of the thallus of some crustaceous species,—as *Lecanora pallescens,* var. *parella,* and *L. rimosa,* —they are developed in the form of minute, solid, cylindrical, or cone-like bodies, arranged perpendicularly to its surface, and so closely aggregated as to form a compact tissue, apparently composed of a multitude of small columns. Such a condition is termed *isidioid,* and is the basis of the old genus *Isidium,* which is thus found to be an abnormal state of the thallus of certain crustaceous species. The isidioid thallus resembles the tartareous in being usually pale or whitish, cretaceous and friable, and in possessing a considerable amount of colorific and mineral matter; the

same may be said, though in a minor degree, of the variolarioid form. The pillar or cone-like bodies constituting the isidioid thallus are frequently dark or coloured at their apices; these were supposed by the older authors to be apothecia, to which, from their form, they gave the name *globuli*. The soredic and isidioid conditions are sometimes combined in the production of fruticulose, powdery masses termed *glomeruli*, which frequently occur on the thallus of *Parmelia amplissima* and *Umbilicaria pustulata*.

The thallus is developed from and upon a rudimentary body termed the *hypothallus*; to understand the proper relations and importance of which, it will be advisable to glance briefly at the progressive development of a Lichen-thallus from the germination of a Lichen-spore. In germinating, under favourable circumstances with regard to moisture, light, heat, etc., the spore, or cellular embryo of a Lichen, sends forth usually from one, sometimes from both of its extremities, and occasionally from all points of its surface, delicate filaments or tubes which gradually become elongated and branched, spreading upon, or piercing, to various degrees, the base of support,—the ramifications intertwining so as to form a loose, felted texture, resembling closely, in general characters, the mycelium of Fungi. This network of

filaments is the hypothallus; its filaments, in progress of development, become continuous with those of the medullary layer of the Lichen-thallus, and possess similar characters. Like them they may consist of a series of elongated cylindrical cells placed in apposition, and are then marked by septa at irregular intervals and usually possess thickened walls; or, the septa of the constituent cellules having disappeared, the filaments are hollow, branching, thin-walled, and simple. In the latter case, however complex the network may appear, it can only be morphologically regarded as the extension and subsequent ramification of the membrane or wall of a simple cell. The hypothallus is in most Lichens evanescent; after it has served as the basis of the thallus, it disappears. In some species it is persistent, and may be recognized as a delicate filamentous network,—frequently having a dendritic and crystalline appearance, sometimes pale-coloured, more usually black,—below or surrounding the thallus. It is characteristic of the Rhizocarpous section of the *Lecideæ*, and may be easily seen in *Lecidea geographica* in the form of a black dendritic radiating fringe, surrounding the yellowish-green thallus. When this species grows on pure milk-white quartz, as it frequently does on our Scotch mountains, this thalline fringe is very conspicuous.

In the progress of onward development there is first noticed, superimposed upon the filamentous network of the hypothallus, a layer of spherical or rounded cellules, colourless or whitish, in close union both with each other and with the subjacent filaments. Upon this cellular stratum there is gradually deposited a second, which is characterized by its constituent cellules being quite globular, free in relation to each other and subjacent textures, and more or less full of chlorophyll granules; these cellules are the *gonidia* of which we have already spoken. We have now attained the essentials of the Lichen-thallus, viz. gonidia, or isolated cellules, and filaments, with which they are intermixed. In some species the thallus attains no higher development, as in the *Verrucariæ*, the most simply organized Lichens. Such Lichens appear indeed destitute of a thallus, but careful microscopic examination will detect the elements we have described. These elements, or, in other words, the possession of this simple and rudimentary thallus, are the only means of distinguishing many Angiocarpous Lichens from species of *Sphæria*, belonging to the allied great family of *Fungi*. In the common *Verrucariæ* and *Graphideæ* of our tree-barks the fructification however appears to spring directly from the surface of the bark, and may in a certain sense be said to con-

stitute the plant. An examination of the pulverulent or rudimentary thallus of many common Cladonias and Lecideas will prove it to be composed of the same elements. In this light also we must regard the old genus *Lepraria* as a persistent hypothalline type or abortive condition of the thallus of various familiar species of the genera just mentioned. In some foliaceous species, the hypothallus becomes developed into *fixuræ*, which are composed of bundles of filaments having the same characters as those described under the head of the medullary layer of the thallus; in some crustaceous species it appears to form the adnate base before alluded to.

The *colour* of the Lichen-thallus is as varied as its form, and as subject to alteration by external circumstances, terrestrial and aerial. It is generally greenish, greyish, or brownish; frequently also whitish, yellowish, reddish, and blackish; or it possesses various shades and combinations of these colours. The colouring matters on which these depend are confined to the cortical layer of the thallus. Of this the student may convince himself by tearing across any very dark-coloured thallus, such as the bronze-coloured or almost pitchy thallus of *Parmelia Fahlunensis*, the external or cortical layer of which is of a deep *brown* colour, while

the centre consists of a *white*, cottony, spongy, medullary tissue, between which and the cortical layer there may be seen a thin layer of *green* gonidia. This colouring matter is in many species easily extracted by boiling water, and other solvents, and has been abundantly applied by the peasantry of Scotland, and other countries, in their household arts, and especially to the dyeing of home-spun vestments. In the majority of Lichens, from the thinness and comparative transparency of the cortical tissue, the bright green colour of the subjacent gonidic layer plays an important part in the production of the colour of the thallus. When a Lichen is steeped in water or moistened, the transparency of the cortical tissue is greatly increased, and if previously of a pale colour, the green of the gonidic layer now shines through it with almost undiminished intensity. This sufficiently explains the circumstance that most Lichens, when moistened by rain or when growing in damp situations, have much more of a green tint than under opposite conditions. It may be laid down as a general proposition, that whatever be the colour of the cortical layer, that of the gonidic stratum is normally and always *green*. Changes in colour are greatly under the influence of *light*, as well as *moisture*. In the vertical thallus, which is equally exposed

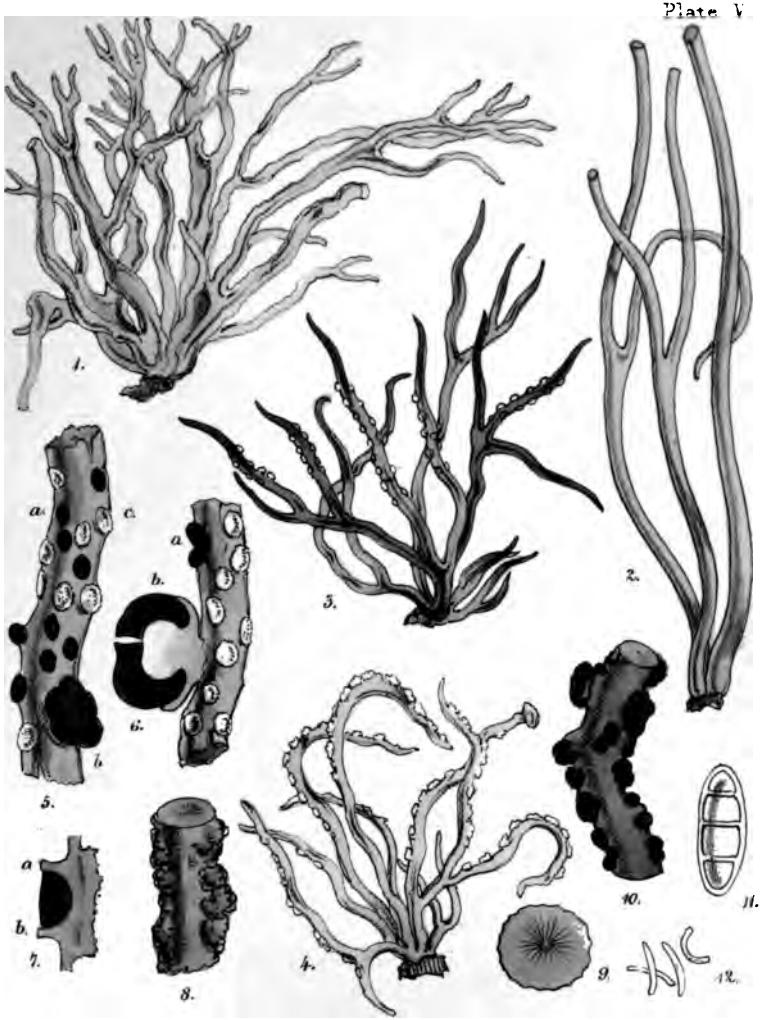
to the light, the distribution of colour is generally uniform; but in the horizontal thallus, the inferior surface, which is opposed to, or in union with, the base of support, is much paler than the superior or free surface, which is exposed to the sun, and not unfrequently of a different colour. While it is more highly coloured, the surface exposed to the light and to atmospheric changes is also, as we have mentioned, from the compactness and thickness of the cortical cells, firmer in texture. Hence species growing in the shade usually present a dull colour in their thallus, while those exposed to the sunlight exhibit bright or deep tints. A marked change in colour may be artificially produced by transferring a species growing in a damp shady locality, to a dry light habitat, or *vice versâ*. But there are a few exceptions: some Lichens, whose normal habitat is the shade, and which are said there to exhibit very bright tints, grow pale on exposure to a greater amount of light; and some tropical Lichens are known to possess very dull colours. It can scarcely be doubted that various mineral matters are, to a slight extent at least, absorbed from the soil or from bases of support, and contribute materially to the colour the thallus; this has been particularly observed in regard to peroxide of iron, which gives a rusty or reddish colour to the thallus of many species.

Before leaving the subject of the *thallus*, we have still a few general remarks to make on the subject of its *growth* and *decay*. In regard to their *food*, Lichens have generally been described as aerial, drawing their sole nourishment from the atmosphere. If however we are guided, as we ought to be, in our determination of the nature of their food, by their chemical composition as ascertained by an analysis of their ash, we must come to the conclusion that they derive no inconsiderable amount, at least of their inorganic constitutive elements, from their *bases of support*. The latter term we employ, not from a common belief with the earlier Lichenologists, that the trees, rocks, or ground on which Lichens grow contribute nowise to the building up of their thallus, but merely as a term of convenience; our own opinion is, that, while the atmosphere supplies the chief organic elements of the thallus, the substance on which a Lichen grows furnishes the chief inorganic constituents. Almost all Lichens, as we have seen, are more or less intimately united to the bodies on which they grow; the surface of the latter is frequently pierced or broken up by the tissues of the Lichen,—nay, the hardest calcareous rock, the smoothest quartz, is corroded and disintegrated; and deeply sunk in their substance we find the

fructification of several species of *Verrucaria* and *Lecidea*. This phenomenon has hitherto been unexplained; it probably depends on some chemical action exerted on the rock by the Lichen. There are however exceptions apparently to the rule that all Lichens are adherent; the *Lecanora esculenta*, which constitutes a kind of manna to the nomadic tribes of the Asiatic steppes in the neighbourhood of the Caucasus, is said to be free at every period of its growth. The *ash* of Lichens constitutes about eight or ten per cent. of their bulk, and consists of various earthy bases—such as potash, soda, lime, magnesia, alumina, silica, manganese, and peroxide of iron, in combination with various acids, such as carbonic, phosphoric, sulphuric, and hydrochloric. As illustrations of the composition of the ash of particular species, Mr. Wallace Lindsay found in that of the common "Iceland moss" of our druggists' shops (*Cetraria Islandica*) the bases lime, potash, soda, magnesia, and peroxide of iron, in combination with sulphuric, hydrochloric, and phosphoric acids; and in that of a very sorediiferous form of *Physcia prunastri*, from the woods of Floors Castle, Kelso, the bases lime, soda, potash, alumina, magnesia, manganese, and peroxide of iron, in combination with the same acids. It is probable that in the former case the inorganic matter was

absorbed from the soil; in the latter, from the bark of the fir and other trees on which the plant grew. We can however approximate proof more closely, for it has been found that iron is detected in many species growing on ferruginous soils, and silica in those inhabiting quartzose rocks. But the chemistry of the Lichens is in a very primitive and unsatisfactory condition; and, until it is more fully studied, the question of the source or nature of their food cannot be satisfactorily determined.

Lichens are perennial; they grow very slowly, but they attain an extreme *age*. Some species, growing on the primitive rocks of the highest mountain-ranges in the world, are estimated to have attained an age of at least a thousand years; and one author mentions, after the lapse of nearly half a century, having observed the same specimen of *Sticta pulmonaria* on the same spot of the same tree. If this be the case, it is impossible to calculate how many ages we must go back in memory to trace the origin of the lichenose coating, the grey and yellow "time-stains," of many a weather-beaten battlement; or to consider what deeds these venerable crusts have witnessed—what changes they have outlived in the past history of our country. The hoary Usneas, Ramalinas, and Physcias of our forest-trees, like the grey beard



W.L.Lindsey del. Etch.lith.

Vincent Brooks Imp.

of an old man, silently but eloquently proclaim Time's ravages, and illustrate the constant succession of life upon death, growth upon decay, which is going on around us. We have alluded to the age of the individual; we shall find no less interest in regarding the *geologic age* of the family. Unger, in his 'Palæo-phytology,' mentions Lichens among the few cryptogamic plants which have been detected in a fossil state in the lower or earlier palæozoic strata. From the cellular character of the lower cryptogamic plants, comparatively few have been preserved to us as fossils. Their presence at so early a period of our earth's history leads to reflection on the condition of lichenose vegetation on our globe at the period when the strata which now contain their remains were originally deposited. It is not inconsistent with analogy to believe—as in the case of an allied family, the Ferns—that the stunted Lichens of our walls or trees are but puny types of a once comparatively gorgeous vegetation, whose nearest living analogues are the large and showy foliaceous species of tropical forests.

We have already alluded to the protean nature of the Lichen-thallus and the frequency of its abnormal conditions. This is perhaps the most appropriate place to review the causes productive of its infinite alterations and metamor-

phoses; in doing so, we shall be led incidentally to consider the chief circumstances which promote or retard the growth of the thallus. The study of these causes and circumstances is one of great importance to the young lichenologist, as a key to the phases or varieties of species. In their influence on the Lichen-thallus no agents are more powerful than moisture, light, and heat; hence we find Lichens attaining their maximum development under maximum conditions of moisture, light, and temperature, that is, in the the tropics. At the same time, however paradoxical it may appear, no plants are more independent of the influence of these agents, for they vegetate in the driest and coldest regions yet discovered by man. Their vitality is more persistent than that of any higher plants; it is frequently suspended for long periods by drought, but growth is at once stimulated by the slightest moisture, which is greedily absorbed by all points of the surface. The effect of moisture in producing a change of colour has been mentioned; it is sometimes more remarkably productive of change in consistence. The flaccid membraniform *Collema*, when moistened, swells up into a jelly-like mass, resembling many of the *Algæ*. Some authors indeed believe that Lichens might be caused to assume algoid characters by making them ve-

getate in a moist or aqueous medium; and Fries, no mean authority, defines Lichens to be "*Algæ* born in the air, interrupted in their development by the deficiency of water, and stimulated into forming a nucleus by light." Excess of moisture seems decidedly prejudicial to Lichen development; it produces a sterile state of the thallus, and favours the production of a pulverulent or persistent hypothalline type. A knowledge of this fact has enabled some authors to cause sterile species to become fertile, by merely altering their habitat. No species grows normally under water, or in habitats devoid of light, though apparent exceptions have occasionally been described. The *nature of the habitat* frequently exercises a powerful influence, not only by means of the organic or inorganic materials which the surface whereon a Lichen grows supplies to the building up of its thallus, that is, by means of its chemical characters; but sometimes on account of its physical structure, such as its capability to absorb or retain heat and moisture. To this subject we shall more fully recur under the head of Geographical Distribution. Season and the vicissitudes of climate are not without their effect, if we may judge by the changes which they appear to produce in the chemical composition or products of certain species. It is well known that many

dye species are richer in colorific matter at certain seasons, at which they are consequently uniformly collected, than at others. The mode of growth in some species, and its fitful and irregular character in all, is also a fertile source of alteration in the form of the thallus. In some foliaceous species, growing equally from a common centre, it sometimes happens that the centre dies and falls away, while the circumference is vigorously extending itself in an exogenous manner, that is, by the production of new peripheral rings. The growth of these rings or zones depends chiefly on moisture; the development of the thallus is retarded or stopped during drought, but is immediately promoted by the slightest rain or dew; and in proportion as the hygrometric condition of the atmosphere varies, so do these rings exhibit irregularities in form and size. Such abnormalities have doubtless formed the basis of many of the "fairy-rings," described as existing on old trees and rocks; they are of common occurrence in *Parmelia saxatilis* and its variety *omphalodes*. Frequently this decaying or dead centre becomes the nidus of a new thalline growth, originating from the gonidia of the old thallus; in such a condition we have a fine example of simultaneous growth and decay in the same individual. The gonidic element of the

thallus in a hypertrophic or abnormal condition is productive, as we have to some extent already seen, of many thalline malformations; it constitutes various epithalline growths, in the form of warts, tubercles, squamules, or folioles; it sometimes covers the surface of the thallus with a thick, powdery coating,—nay, it is the basis frequently of a pulverulent degeneration, characterized by the destruction of all other tissues of the thallus. In a word, the pulverulent, sorediiferous, variolarioid, and isidioid forms of the thallus, to which a hypertrophic condition of the gonidia gives birth, so completely change its aspect, as to have led the older authors to constitute species possessing such a vegetative system into distinct genera.

The *Reproductive system* of Lichens is divisible into the *Primary*—normal or typical, wherein it resembles,—and the *Secondary*, or supplementary, whereby it is distinguished from, that of plants higher in the scale of vegetation. The primary reproductive system consists of the following parts or organs:—1. *Apothecia*, which generate and protect the cellular embryos or *spores*, by whose germination and subsequent development the species is reproduced; 2. *Spermogones*, which produce and discharge at certain periods of the growth of the plant minute bodies, *Spermatia*, whose function

is now generally acknowledged to be the fertilization or fecundation of the spores: and 3. *Pycnides*, which give rise within their cavities to spore-like bodies, termed *Stylospores*, whose precise office in the physiology of reproduction does not appear yet to have been accurately determined. The Secondary reproductive system consists of the *Gonidia*, of which we have already spoken. While the spore is a cellular embryo, a reproductive cell prepared by a process of fecundation, destined to the propagation of the species, the gonidium is a cellular bud, a reproductive cell, which has undergone no preparatory fertilization, destined to multiply the individual. As we have seen, the latter may multiply either on some part of the parent thallus,—as in the folioles or squamules of the *podetia* in the *Cladoniæ*,—or external to the parent thallus, as in the rudimentary vegetative system of the same genus. The *apothecia* are generally easily recognizable on some part of the thallus; they have long been familiar to Lichenologists, some of whom have taken their characters as the basis of classification. The *Spermogones* and *Pycnides* have only been fully discovered and described within the last few years: a knowledge of their structure and relations is the key to many hitherto difficult problems in the natural history of the Lichens. The former are so minute

as to require frequently a careful examination for their detection; they usually coexist on the same thallus with, and in proximity to, the apothecia, and occur in the form of tubercles or dark points, which the older Lichenologists described as epithalline growths, parasitic Fungi, etc. The latter, the *Pycnides*, are similar organs, occurring however only in a very few minute parasitic Lichens. To acquaint ourselves fully with the structure and constituent elements of these various organs, it is necessary to apply comparatively high powers of the microscope.*

* Thanks to competition in the manufacture of optical instruments in Britain and on the Continent, the student can now provide himself with an excellent compound microscope, at a comparatively low price. Among the best and cheapest instruments are those made by Nachet and Oberhauser, of Paris, which can be procured for from £5 upwards. Those reaching a magnifying power of four hundred to six hundred diameters, should be selected by the student whose object is the investigation of the minute anatomy of the Lichens; for ordinary studies in vegetable anatomy, instruments reaching a power of two or three hundred diameters are sufficient. Most British opticians, by using French or German lenses, can now supply excellent instruments at a moderate price; and in consequence of prizes recently offered by the London Society of Arts, for the best and cheapest students' microscopes, a Birmingham firm (Messrs. Field) advertises them at a price ranging from 10*s.* 6*d.* up to £3. Among the most celebrated London makers are Ross, Powell and Lealand, and Smith and Beck; and in Edinburgh, Messrs. Bryson have had much experience in their construction.

The *Apothecium* (*ἀποθήκη, a repository*) consists normally of two distinct parts, the *Thalamium* (*θάλαμος, a receptacle*) and the *Exciple* (*excipio,* to receive); in some cases the latter is absent. The *thalamium* is either typically *open,* forming a more or less flattened, concave or convex disc, as in the Gymnocarpous (*γυμνὸς, naked,* and *καρπὸς, fruit*) section of the Lichen family; or it is typically *closed,* forming a globular or nucleiform body, which opens in a state of maturity by a minute ostiole or pore, or by an irregular fissure with lacerated edges, as in the Angiocarpous section. The *exciple* is a capsule or envelope enclosing or protecting the thalamium. In some cases it merely forms a margin or border bounding its sides; in others it constitutes both base and border; in the *Angiocarpi* (*ἄγγος* or *ἀγγεῖον, a vessel*) it forms a more or less complete globular envelope, which is designated the *Perithecium* (*περὶ, round*).* The exciple is said to be *thalline* when it is formed of an extension of the cortical layer or other tissues of the

* The perithecium is said to be *entire* when it quite surrounds the nucleiform thalamium; *dimidiate* (*dimidiatus,* halved) when situated on the upper or exposed half only. Leighton also applies the term to the carbonaceous exciple of the *Graphideæ,* which is *entire* when enclosing the sides and base of the thalamium, to which it gives a proper margin, as in *Opegrapha;* and *dimidiate* when confined to the sides, the base being naked, as in *Graphis.*

thallus, in which case it is of similar colour therewith; and *proper* when it possesses a dissimilar structure and colour, as in *Lecidea* and *Calicium*. Each exciple usually contains a single thalamium, but sometimes two or three are aggregated together, both in Angiocarpous and Gymnocarpous species, forming confluent or symphycarpous apothecia, as in some *Cladoniæ*. In form the apothecium is usually round; sometimes it is linear, elongated, or irregular. It is said to be *scutellate* (*scutella*, a platter) when round, flattened, or plate-shaped with a thalline exciple, as in *Parmelia* and *Lecanora*; *peltate* (*pelta*, a buckler or target) when of similar form, but destitute of a distinct exciple, as in *Usnea*, *Cetraria*, and *Peltigera*; *patellate* (*patella*, a shield) when round, convex, or semi-globular, with a proper exciple, as in *Lecidea* and *Calicium*; *capitulate* (*capitulum*, a head) when irregularly round, globular, and seated on the apex of a stem-like prolongation from, or form of, the thallus, as in *Cladonia*, *Stereocaulon*, and *Bæomyces*; *lirellate* (*lirella*, a furrow) when linear, or elongated in the form of a chink or furrow, frequently irregularly divergent or stellate, with a proper exciple, as in the *Graphideæ*; and *verrucous* (*verruca*, a wart) when globular or wart-like, seated directly on or partially in the thalline surface, the exciple being a

perithecium, as in *Verrucaria*. In regard to its mode of fixture to the thallus, the apothecium may be *sessile*, when adnate or immediately adherent to, and seated on, the surface of the thallus; partially *innate* when its base is immersed in the superficial thalline tissues; *pedicellate* or *stipitate* when fixed on the apex of a stalk-like projection, as in *Calicium*. In respect to its position on the thallus—in foliaceous species it may be *central*, as in many Parmelias, or *marginal*, as in *Peltigera*; while in fruticulose species it is either *lateral*, as in many Ramalinas, or *terminal*, as in *Sphærophoron* and *Stereocaulon*. Abnormal or abortive states of the thalamium or exciple, but particularly of the latter, frequently give rise to great irregularities in the characters of the apothecium in the same species. The scutellate apothecium sometimes becomes patellate from the border of the exciple being so reflexed as to allow the thalamium to cover and conceal it, as in *Lecanora ventosa*; and on the other hand the patellate may become scutellate by an inflexed condition of the margins of the thalamium, and the assumption, real or apparent, of a thalline exciple. Some apothecia in the young state are covered or veiled by an extension of the cortical thalline layer or by a delicate dehiscent membrane, as in *Peltigera*. The *rudimentary apothecium* appears as a globular

nucleus in the medullary thalline tissue; it gradually becomes enlarged and approaches the surface. In some cases—the majority of the *Gymnocarpi*—it bursts through the cortical layer, which may or may not form a margin, in the former case constituting a rudimentary exciple; in a few instances the cortical layer, an extension thereof, or a peculiar membranous veil, covers the apothecium up to a certain stage of its development, as in *Peltigera;* while in the *Angiocarpi* the cortical layer would appear to be extended over the nucleiform thalamium in the shape of the perithecium. This capsule or outer covering—the perithecium—which is frequently black, and sometimes red or pale-coloured, is generally lined by a somewhat tough membrane, dark or pale-coloured, which directly encloses the thalamium. The *colour* of the thalamium is not fully developed until the apothecium arrives at maturity; it is as varied as that of the thallus. In the very young state it is pale or colourless; when mature it has various shades or combinations of brown, black, red, and yellow. In some species its colour is very vivid and beautiful; for instance, the bright scarlet apothecia of a section of the Cladonias. The colour of the thalamium resides in, and is due to, the terminal cells of the paraphyses, its chief constituent elements, of which we

shall immediately speak. Sometimes its colour is similar to that of the thallus; more frequently it is dissimilar, and of a much more vivid or dark tint. The exciple however is frequently of the same colour with the thallus, and is therefore dissimilar in colour to the thalamium, than which it is thus usually paler or lighter.

The *Thalamium* is made up of a series of elongated cells or cellular bodies arranged vertically to its surface; they are in a state of close aggregation, and are united by means of a mucous or glutinous matter; they arise from the minute, spherical, somewhat irregular cells of a tissue, which forms the base of the apothecium, and is hence denominated the *hypothecium*. These bodies are called respectively *thecæ* (*θήκη, a sac*) and *paraphyses* (*παράφυσις, an offset*). The hypothecial cells, from which they spring, usually rest immediately on the medullary layer of the thallus.

The *Paraphyses* are elongated, linear, club-shaped bodies, composed of a series of six or eight cylindrical cells, in apposition by their extremities, whose walls are delicate, and whose contents are a hyaline mucous matter; the terminal cells—the aggregation of which constitutes the surface of the thalamium—differ in being irregularly round, frequently marked by wart-like bulgings, and in possessing coloured

contents, most usually brown, which are sometimes coarse and granular. It was formerly generally supposed that these bodies were simple filaments or tubes, undivided by septa and devoid of contents; but the application of sulphuric acid or iodine under the microscope, by rendering evident the septa of the constituent cells and coagulating or colouring their contents, proves this opinion to be fallacious. Some theorists have described the paraphyses as prolongations or modifications of the filaments of the medullary layer of the thallus; others have regarded them as rudimentary, sterile, or abortive thecæ. The former theory is proved to be erroneous, by their having been found by the latest observers to arise from the hypothecial cells, as already stated; the latter equally so by the consideration that they precede the thecæ in the order of development, and possess *ab initio* a distinct structure, and apparently a distinct function.

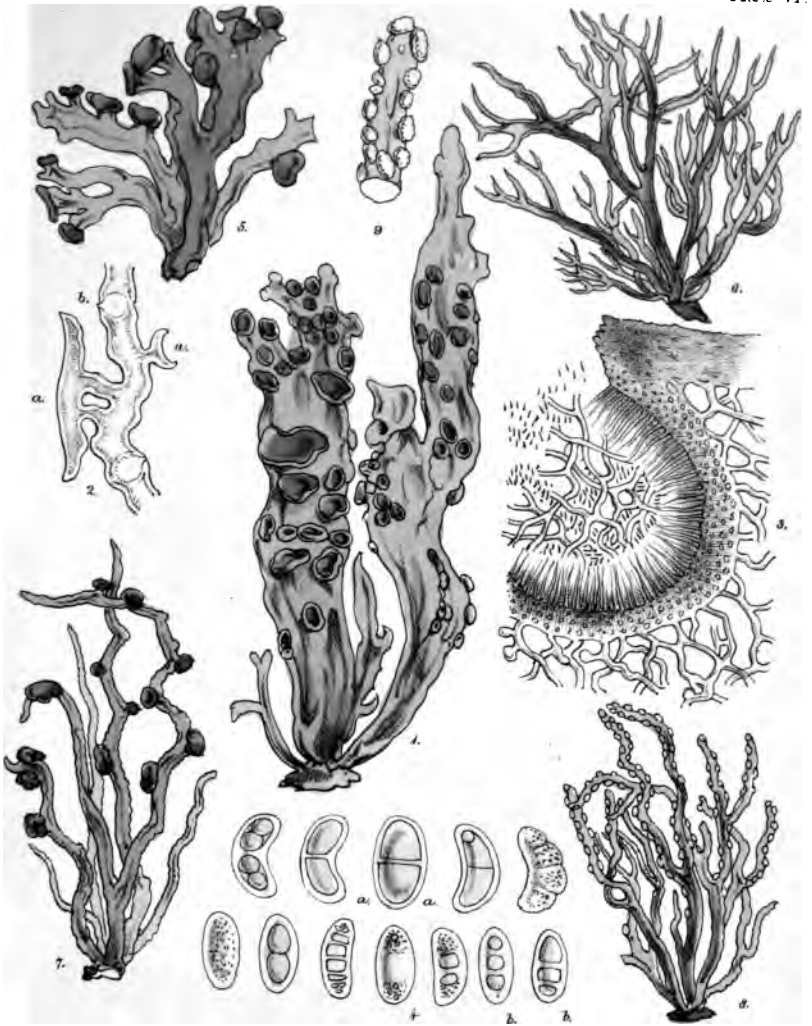
The *Thecæ*, which may be regarded as the parent cells of the spores, are amylaceous, membranous sacs, varying much in size and shape, but always inferior in length—and greatly superior in breadth—to the paraphyses, and usually either of an obovate, ellipsoid, linear, or clavate form, the superior extremity being dilated and obtuse, the inferior tapering suddenly or gradually into a narrow pedicle or filament.

The pedicle at its free end is frequently bent or twisted; this is a remnant of the original development of the theca, which springs laterally from a hypothecial cell. The form of the theca depends chiefly on the state of maturity of its contents; in the young state, it is generally more or less narrow, but it becomes regularly or irregularly dilated as the spores are developed. The effect of maturescence of the spores, in producing a marked change of form in the theca, may be easily studied in *Parmelia parietina* or *Physcia ciliaris*. The thecal wall is somewhat thick; its thickness is greatest in the young state, and at the apex of the theca; hence iodine, which tinges it, on account of its starchy character, of a beautiful prussian-blue colour, developes the greatest intensity of tint at the apex, or superior extremity of comparatively young thecæ. The inner surface of the thecal wall is normally lined by a delicate membrane, differing from it in its chemical characters, which forms a shut sac or cell, similar in size and appearance to the theca itself, and which is called the *spore-sac*. This membrane is not only closely applied to the interior of the thecal wall, but is frequently incorporated with it; it can seldom be recognized as a distinct membrane, unless under the action of chemical reagents. It would appear—probably

from the difficulty of its recognition—that it is sometimes absent. The contents of the young theca are, first, a hyaline, mucous, or hazy granular matter. In progress of development this becomes more coarsely granular, and in some species, such as *Lecanora pallescens* var. *Parella* and *Pertusaria communis*, large oil globules, in greater or less abundance, make their appearance; a number of the larger granules become aggregated in nuclear masses: these assume a definite form and acquire a membranous investment. The outline of the young spores is now distinctly visible; the granules fuse themselves into a more homogeneous mass; the spore enlarges, its wall thickens, and it gradually acquires colour. Each theca contains usually, when fully developed, eight spores,—sometimes only four, two, or even one; very seldom does it contain an innumerable quantity, as in some *Endocarpons*. When the spores arrive at maturity, the theca becomes ruptured at the apex, so as to allow of their escape; sometimes it is ruptured or partially decayed considerably prior to this period; and in exceptional cases it is even said to be altogether absent, its place being supplied by the spore-sac. After it has fulfilled its office—the genesis and bringing to maturity of the spores—the theca becomes shrivelled and disappears; but a constant succession of

thecæ is sent forth by the hypothecium during the life of the apothecium, which, like the thallus, is perennial.

The *Spore* (*σπορὰ, a seed*) varies greatly in form, size, and colour. Its form is usually ovoid or ellipsoid; sometimes fusiform, elongated, or linear. It is either simple, consisting of a single cell; or compound, formed of, or containing, two or more smaller cellules arranged in definite series, and usually separated by distinct intervals or septa, or dissimilar in size, and aggregated in a confused manner, constituting what are termed *cellular spores*. The one-celled or simple spore is usually simple also in shape; the compound spore, on the other hand, presents great irregularity. When the spore consists of two large cells in apposition by one surface, it assumes somewhat of the appearance of the figure 8, modified by pressure; where there is a greater number of constituent or contained cells, the spore-wall presents a series, regular or irregular, of bulgings. In one species, the common *Pertusaria communis* of our trees, the spores are so large when isolated and spread on a slip of glass, as to be, on careful examination, visible to the naked eye; in other common species, such as the Cladonias, on the other hand, they are so small as to require high powers of the microscope for their discrimination; between these



... Lancaxay del Pitchlith.

Vincent Brooks Imp.

there is great variation in size. We would recommend the student to study the spore and the tissues which enclose it in *Pertusaria communis*, *Physcia ciliaris*, *Parmelia stellaris*, and *Parmelia parietina*, all of which are common species. Their colour is most frequently a pale straw-yellow; sometimes they are brownish or reddish; a few have an intense olive colour. In the young state most spores are colourless; and even when mature, many spores appear colourless individually, while they have a distinctly yellow tint *en masse*. The spore-wall varies in thickness; typically, it is composed of two membranes, the outer constituting the *Epispore* (ἐπὶ, *upon* or *on the outside*), the inner being denominated the *Endospore* (ἔνδον, *within*). Frequently only one of these can be observed, usually the outer. The epispore is generally pellucid and smooth; sometimes it is coated with the remnants of the protoplasmic or mucous matter from which it was originally developed; in one species (*Solorina saccata*) its surface has been described as granular, and in another (*Thelotrema exanthematicum*) it is said to be bristled over with very fine, transparent points. The contents of the young spore consist usually of mucous and granular matter, intermixed in some species with a quantity of large oil globules; as it advances to maturity,

these generally become fused into a homogeneous mass, which is frequently of an oily nature. The spores are lightly agglutinated to each other by the mucous protoplasm from which they were first developed, but at no period of their development are they attached to the walls of the theca or its spore-sac. Where they exist to the number of eight or upwards in a theca, they have appeared to us to be arranged usually in a spiral manner. From the disappearance of the thecal walls prior to the maturity of the spores, they sometimes appear naked, or extrathecal. When mature they escape from the theca by rupture of its apex; they then find their way to the surface of the thalamium, in gymnocarpous species, whence they are removed by the winds or rains. In the *Angiocarpi* they accumulate in the cavity of the thalamium, and issue by the terminal pore or fissure; in some species, by their agglomeration, they form pulverulent or scobiform masses on the surface of the thalamium, which appears covered with a bluish-black dust. In *germinating,* one or both ends of the spore usually become lighter in colour: gradually a bulging takes place, apparently by projection of the endospore, or inner membrane, through a rupture or solution of continuity in the epispore, or outer; this bulging is prolonged into a filament, whose ramifications

and intertwinings result in the formation of the hypothallus, as we have already seen. For a considerable period the characters of the spore otherwise continue the same; gradually however its surface becomes shrivelled and opaque; its contents, whether cells or granules, disappear; and finally, the spore loses form, or is soon lost amid the hypothalline network of filaments. Some authors have alluded to a peculiar *motion* as occurring in the spores of certain species when mixed with water; but there is every reason to believe that this has merely been the molecular or Brownian movement, now so familiar to botanists.* The mechanism of the *expulsion of the spores* to the surface of the thalamium is a very curious one: it appears that, under the influence of moisture, the thalamium expands, while the exciple contracts; the result is a degree of pressure upon the thecæ sufficient to cause their rupture and the simultaneous expulsion of the spores.

The *Spermogones* (σπέρμα, *a seed*, and γονὴ, *generation*) are usually minute capsules or cysts, immersed in the sub-

* It is designated *molecular* from its frequency in organic or inorganic matter in a state of fine division when suspended in water; and it is called *Brownian* from its nature having been first distinctly pointed out by one of our greatest living botanists, Robert Brown, of the British Museum.

stance of the thallus, and opening on its surface by very delicate pores. Sometimes they are superficial, and seated on the extremities of the thalline segments, or of various appendages, as in *Cetraria* and *Cladonia*. The cavity of the spermogone is usually simple and rounded; sometimes it is divided into two or more sinuous cavities or cells, in which case its form becomes more elongated and irregular. Its outer wall or envelope is generally dense and coloured, frequently dark brown or black, especially towards the apex of the organ, or that portion of it which is visible on the surface of the thallus; it is then easily distinguishable, and may be separated in the mature state from the surrounding thalline tissues. Sometimes however the walls are pale-coloured, and more or less adherent to, or incorporated with, adjacent textures. Its inner wall is composed of a series of delicate, simple or branched, one-celled or jointed filaments, which, from their function as the generators or supports of the spermatia, are denominated *Sterigmata* (*στήριγμα, a support*); these are arranged vertically to the outer wall, and project in a convergent manner into the cavity of the spermogone. They are very hygrometric, imbibing water with the greatest rapidity; and they are bathed in a copious transparent gelatine, which fills more or less the whole

cavity of the spermogone. From their apices or sides the sterigmata generate the *Spermatia*, which are minute, acicular or linear bodies, straight or curved, varying in length and breadth, sometimes oval or ellipsoid, colourless, transparent, and which sometimes exhibit Brownian movements, but are destitute of cilia or other appendages. When thrown off from their parent cells, these bodies gradually accumulate in the cavity of the spermogone to such an extent that, when full of spermatia, this organ becomes so dense that it may frequently be picked out of the thallus by means of a needle-point: they ultimately escape from the spermogone by means of its apicial pore. These bodies may be regarded functionally as the analogues of the antherozoids of the *Chara*, seaweeds, and other higher cryptogamic plants, from which however they differ remarkably in being developed on the exterior, instead of in the interior, of the parent cells. The spermatia are developed long prior to the spores; and it is most important that the student should bear this in mind, as it is the key to the relation of these bodies to each other in respect to function. He will therefore select for the study of the spermogones and their contents young plants prior to the development of their apothecia, and will carefully look for them in the form of black point-like bodies, scattered,

irregularly or in groups, over different parts of the surface of the thallus. He will then ascertain that the spermatia precede the spores, sometimes by several months; that, while he finds the former in autumn or winter, he may not discover the latter till the following spring or summer; and that by the time the apothecium and spores are mature, the spermogone is an empty or shrivelled cyst, all trace of the spermatia having disappeared. Ignorance of this circumstance is one great cause why their existence has been so long overlooked; for observations on the reproductive system of Lichens have chiefly been made on plants whose apothecia had arrived at maturity. Reflection upon the analogies of the subject however will make it apparent that we can as reasonably expect to find mature spermatia in their spermogones, co-existent with mature spores in their apothecia, as to discover stamens in phanerogamic plants when their seeds are ripe. Another great cause of the total absence hitherto of a knowledge of the characters or functions of the spermatia is undoubtedly their extreme tenuity, and the consequent necessity of applying high powers of the microscope to their examination. In our speculations on the influence of the spermatia upon the spores, it is important to bear in mind that, in regard to their position on the plant, the spermo-

gones stand in the same relation to the apothecia that the organs which contain the fecundating bodies in higher plants bear to those which generate the seeds or their analogues. It must be distinctly understood by the student that no distinct proof has as yet been attained as to the fecundating influence of the spermatia or stylospores on the spores, and that therefore the part which these bodies play in the function of reproduction is still a matter only of probability.

The *Pycnides* (πυκνότης, denseness or closeness, *Pycnitis*, Lat.) and their contents, from their rarity, require only a few words of explanation. They have been discovered and described by Tulasne, in the Memoir formerly alluded to. Their chief interest lies in their being a link in the chain which connects the Lichens with the Fungi, as they exist to a greater extent in the latter group of plants. They differ from the spermogones in being larger, having thicker walls, and in developing from the extremities of simple, tubular, tapering filaments or pedicles, bodies which, in their size and general appearance, more resemble spores than spermatia. These bodies are called *Stylospores* (στῦλος, *a pillar*), from being generated from the end of pedicles or stalk-like filaments; they are usually somewhat oblong,

slightly curved, colourless, and contain amorphous granular matter.

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CHAPTER III.

USES OF LICHENS.

"Things which are often deemed the most insignificant and contemptible by ignorant men, are by the good providence of God made the means of the greatest blessings to his creatures."—LIGHTFOOT.

"Ne doutons point que chaque chose n'ait reçu sa place dans l'ordre établi par l'Eternel; toutes les plantes seroient reconnues pour être utiles, s'il étoit donné à l'homme de tout connoître."—WILLEMET.

WE shall consider, firstly, the great importance of Lichens in the grand economy of Nature, as the pioneers and basis of all vegetation; and secondly, their various applications to the comforts or necessities of man. Under the latter head we shall speak of their uses, in the form of food, to man and the lower animals, and their applications in medicine and the arts.

The late Dr. Patrick Neill,—in his excellent article *Lichens* in the 'Edinburgh Encyclopædia,' to which we have much

pleasure in referring the student,—eloquently describes the Lichens as "one means of that gradual but never-ceasing disintegration or decay, which is wearing down the densest and loftiest pinnacles of the earth." We shall select for illustration of the part which they play in the *formation of soil* fitted for the germination and growth of higher plants, a saxicolous, crustaceous species, growing on the bare quartz summits of some of our Highland mountains,—

> "Cradled in storms, and nurtured by the hand
> That clothes with varied forms the face of earth,
> And fills creation's fields with joy and mirth:"

or we may suppose its habitat to be the bare lava of a volcanic district, or the equally sterile surface of a newly upraised coral island. The delicate spores of such a species have been wafted thither by a breeze, or washed to its surface by a shower: they germinate, and develope a thallus which becomes adherent to the rocky surface by a process of disintegration. From the atmosphere chiefly, and from the rock perhaps to a slight extent, the plant derives nourishment, grows, and in course of time dies, thereby adding to the thin stratum of mineral soil, which it has produced, a thicker layer of vegetable soil. This soil is now suited for fruticulose or foliaceous Lichens; these in their turn decay,

and contribute to the increase of the vegetable soil, which is next taken possession of by mosses and ferns, and gradually by various phanerogamic plants, shrubs, and trees:

"They fall successive and successive rise;
So generations in their course decay,
So flourish these when those are pass'd away."

One of Nature's truest poets, Crabbe, describes this alternation of life and death, birth and decay, in the gradual development of vegetation, so well, that we cannot here refrain from introducing it:

"Seeds, to our eyes invisible, will find
On the rude rock the bed that fits their kind.
There, in the rugged soil, they safely dwell
Till showers and snows the subtle atoms swell
And spread the enduring foliage: then we trace
The freckled flower upon the flinty base:
These all increase, till, in united years,
The stony tower as grey with age appears
With coats of vegetation thinly spread,
Coat above coat, the living on the dead:
These then dissolve to dust and make a way
For bolder foliage, nursed by their decay:
The long-enduring ferns in time will all
Die and depose their dust upon the wall,
Where the wing'd seed may rest till many a flower
Shows Flora's triumph o'er the falling tower."

Travellers agree in describing Lichens as the first plants to

settle on lava, coral islands, and on the bare rocks of mountains; and when we consider that our earth must have at one time presented a similarly naked surface, it is not improbable to conceive that, without a soil prepared, as we have described, by crustaceous Lichens, there could have arisen no higher vegetation,—that without vegetation herbivorous and carnivorous animals could not have existed, and that as a necessary and correlative result, man himself could never have appeared, or must speedily have become extinct. The variously tinted crusts which soften and adorn our cliffs and rocks or the venerable ruins of ancient castles and abbeys, and the shaggy beard of grey which clothes the monarchs of our forests, are evidences that the Lichens are no insignificant elements in the *picturesque*. Linnæus denominated the mosses *Servi*—handmaids of Nature: we think the reader will agree with us in considering that the Lichens have a superior claim to the appellation.

The use of certain Lichens as *food for man and the lower animals* depends on their containing amylaceous and gummy matters; in addition, some species contain minute quantities of peculiar saccharine principles. The amylaceous matters consist of two substances, allied in composition, viz. *Lichenin*, or Lichen-starch,—peculiar to the Lichens; and *Inuline*,

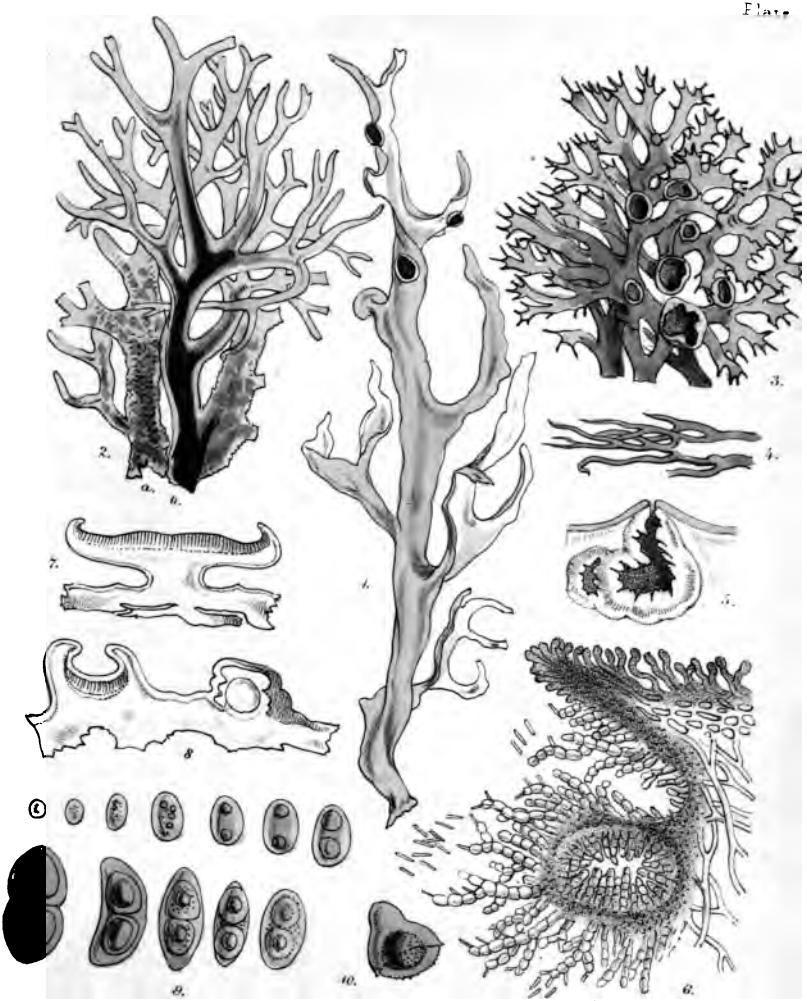
which is also found in the Dahlia, Elecampane, and other phanerogamous plants; the former exists more or less abundantly in all Lichens, the latter to a limited extent only in certain species. Lichenin may be considered intermediate in composition and characters between the substance termed *dextrine* and common starch; in different species it occurs forming the walls of certain cells, it lines their interior, or it constitutes the basis of the cell-contents or intercellular substance. Diluted and boiling sulphuric acid convert it into sugar, while nitric acid transforms it into oxalic and saccharic acids. Inuline, which has been detected in *Cetraria Islandica*, may be regarded as intermediate between common starch and sugar; so that the two forms of starch occurring in Lichens fill up gaps in the series of the four chief chemical substances which enter into the composition of the tissues of plants, viz. Cellulose, Starch, Dextrine, and Sugar. Various common species have long been known to yield a *gum* similar in properties to gum-arabic, for which it has been recommended as a substitute; such species are *Ramalina fraxinea*, *Parmelia ceratophylla* var. *physodes*, and *Physcia prunastri*. One of the projects of the late ingenious Lord Dundonald was to apply this gum to calico-printing. The *saccharine* principles found in minute quantity in some

species are of the nature of *Mannite*, or the sugar of manna. By a beautiful provision of Nature, nutritive species occur precisely under the circumstances where they are most wanted—in northern or Arctic countries, or on arid steppes, where grain-stuffs are unknown, and food of a better kind is frequently scarce or deficient. In illustration we shall only here cite the "Iceland Moss" (*Cetraria Islandica*), which, in the form of bread, soup, or jelly, or mixed with other articles of diet, constitutes the basis of the food of the poor Icelander, and which he also gives as fodder to his cattle and domestic animals; the "Reindeer Moss" (*Cladonia rangiferina*), which frequently forms the principal winter food of the Reindeer, the chief or sole wealth of the Laplander: the "Tripe de Roche," or Rock Tripe, of the Arctic regions (various species of *Umbilicaria*), which has frequently been the means of preserving for weeks or months the lives of the enterprising bands led by Franklin and other Arctic travellers; and a kind of manna (certain species of *Lecanora*), which has sometimes served as food for hordes of men and cattle in the arid steppes of various countries lying between Algiers and Tartary. In many countries various Lichens are collected as winter fodder for cattle; and in northern latitudes, especially during winter, they serve as food for wild animals.

In mediæval *medicine,* in this and other countries, the Lichens were used to a considerable extent, chiefly as nutrients, demulcents, febrifuges, astringents, tonics, purgatives, and anthelmintics. Not a few were supposed to be endowed with specific virtues, such as the common *Peltigera canina,* which formed the basis of the celebrated "pulvis antilyssus," or "pulvis contra rabiem," long regarded as a sovereign cure for hydrophobia. At the present day in this country only one species is used to any extent, as a nutrient and demulcent, in various dyspeptic and chest affections—the *Cetraria Islandica,* or "Iceland Moss," immediately above alluded to, which is to be met with in all our druggists' shops. The virtues of Lichens in medicine are certainly more imaginary than real, though they appear to possess to a small extent some of the properties attributed to them. Their nutritive and demulcent properties depend on the presence of the starchy and gummy matters already mentioned. Several species yield to boiling water a jelly, which, when deprived of certain bitter substances, which are also extracted by the water, and flavoured with sugar and spices, mixed with coffee, or forming the basis of soups, constitute very light and agreeable articles of diet; such are *Cetraria Islandica, Sticta pulmonaria,* and some

Umbilicarias. Their other properties are due to the presence of bitter principles, such as *cetraric acid*,—or astringent substances, such as *gallic* or *tannic acid*. Hence the employment of the common *Parmelia parietina, Physcia furfuracea* and *prunastri*, some *Cladonias*, and the variolarioid forms of *Pertusaria communis*, as febrifuges in intermittent and other fevers, or as astringents in various intestinal and chest affections; of *Cetraria Islandica* and *Sticta pulmonaria* as tonics; or of various *Umbilicarias* and *Peltigeras* as purgatives or vermifuges.

But the most important economical application of the Lichens is based on the valuable purple *dyes* which many species are capable of yielding. These are producible, and are usually produced in the course of manufacture, whether on the large or small scale, by the joint action of atmospheric air, water, and ammonia on certain colourless, nitrogenous, organic acids, which, from the names of the genera in which they have been first or chiefly found, have been denominated by their discoverers *Orcellic, Lecanoric, Gyrophoric, Evernic* acids, etc. The metamorphosis of colour appears to take place, in connection with certain alkalies, by a process of oxidation; but we cannot here enter on the chemistry of the change or of its products. This subject, we



Lindsay del. Bird...

are bound to confess, is in a most unsatisfactory condition: we stand much in want of a series of investigations on the composition and products of the Lichens before it can be properly understood; for hitherto scientific evidence has either been excessively vague or contradictory. In their commercial form the purple colouring matters of Lichens constitute the pigments termed respectively Orchill, Cudbear, and Litmus, which may be practically regarded as various names for the same substance, which differs in character according to differences in the mode of its preparation,—Orchill being its English, Cudbear its Scotch, and Litmus its Dutch name,—the first being manufactured in the form of a liquid or paste of a rich purple colour, the second occurring in the form of a powder of a crimson or carmine tint, and the third being met with only in the form of small oblong cakes of an indigo-blue colour. Their colour is naturally reddish: the blue tint is communicated by the addition of alkalies, while consistence is produced by chalk, gypsum, and similar substances in a state of powder. These colouring matters, in some of their forms, have probably been known from remote antiquity. There is reason to believe that the dye mentioned in Ezekiel (c. xxvii. v. 7)—"Blue and purple from the isles of Elishah was

that which covered thee," and the celebrated "purple of Amorgos," were orchill. These dyes, which we may henceforth, for convenience' sake, denominate Orchill,—the name by which their chief form has been longest familiar in commerce,—are now largely employed, chiefly in combination with other colouring matters, in dyeing or staining with various shades of red, purple, or blue, woollen, silk, and cotton fabrics, leather, wood, marble, feathers, and paper; in the making of size-paint for walls, and of the pigments termed *lakes*. The *rationale* of their manufacture is the making of the cleansed and powdered Lichen into a pulp with water; the addition of an ammoniacal liquid, chiefly in the form of gas-liquor; and the maceration of the mass in a moderately warm locality, for periods varying from several days to several weeks. A process of fermentation takes place, and by the end of this period the mass has assumed a beautiful purple colour, and retains a peculiar ammoniacal aroma. This process the student may imitate for himself on the small scale, and may thus be enabled to test the colorific value of common native species. He has merely to macerate, in a small vial or other convenient vessel containing a mixture of hartshorn (liquid ammonia) and water, sufficiently strong to be disagreeably pungent,

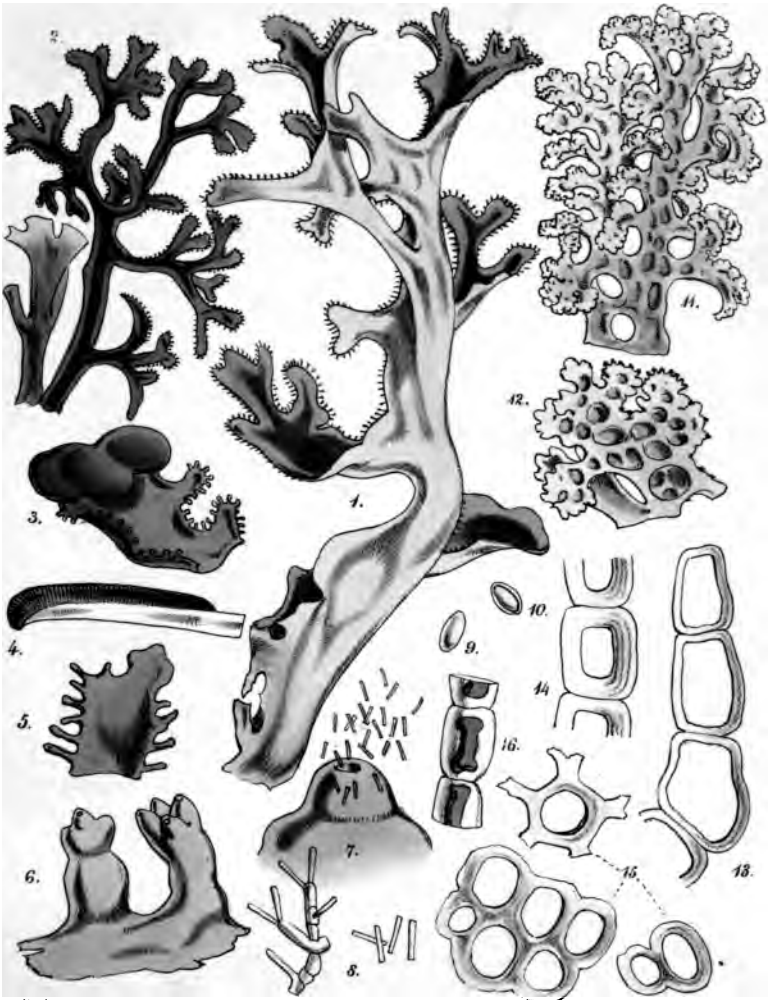
a small quantity of the powdered Lichen; if it contain any of the colourless colorific principles capable of generating purple dyes, the liquid will speedily assume a reddish tint, which, should they be abundant, will become developed into a rich purple. He may use more elegant colorific tests, but we are convinced, from our own experience, that none will be found so easy and so successful as the above. He may make in a test-tube an alkaline or alcoholic solution of the Lichen, by boiling or maceration; the addition of a few drops of a solution of common bleaching powder (chloride of lime) will then cause the development of a fugitive red tint, if it contain any of the colorific principles in question. This reaction depends on the circumstance of this solution (which may be considered chemically a solution of hypochlorite of lime) striking a fugitive blood-red colour with any of the organic acids before mentioned. Or he may macerate the Lichen in milk of lime, and precipitate by hydrochloric or acetic acid its colorific principles, which he can subsequently collect and weigh. By the aid of such simple chemical experiments we some years ago made a series of investigations, with a view to ascertain whether many native and colonial Lichens could not be made available in dyeing, and especially as substitutes for the com-

paratively few and expensive species now employed in the manufacture of orchill, cudbear, and litmus.* We cannot specialize the results, but they were sufficiently encouraging to warrant us in recommending the subject to the attention of all who are likely to travel, at home or abroad, in localities which are rich in crustaceous and fruticulose Lichens,—that is, in mountainous or maritime districts. We found that the species most likely to yield valuable colorific results are those growing on rocks, having a crustaceous, whitish, warted, friable thallus; that, to a certain extent, colorific quality is proportionate to the kind or degree of sorediiferous degeneration of the thallus; that showy foliaceous species are least likely to yield purple dyes, though they frequently furnish yellowish, greenish, reddish, or brownish colouring matters; and that, short of actual experiment, it is impossible to predicate colorific value, the colour of the thallus

* The results were laid before the meeting of the British Association, at Glasgow, in September, 1855, and before the Botanical Society of Edinburgh on various occasions during the years 1852, 1853, and 1854; *vide* Edin. New Philos. Journal, Oct. 1854, Jan. and July, 1855; 'Phytologist,' vol. iv. pp. 867, 901, 998, 1068, and vol. v. p. 179. Series of specimens, preparations, and drawings, illustrative of the economical applications or uses of British and Foreign Lichens (collected or made by the Author) will be found in the National Industrial Museum for Scotland, and in the Museum of Economic Botany, Royal Botanic Garden, Edinburgh.

being a most deceptive guide. The genera containing the most valuable dye species are *Roccella, Lecanora, Umbilicaria, Parmelia, Urceolaria, Physcia,* and *Ramalina.* A few species belonging to one or more of these genera have long been employed by manufacturers in the preparation of orchill, cudbear, or litmus, such as *Roccella tinctoria* and *fuciformis* by the English orchill maker, or *Lecanora tartarea* by the Scotch cudbear-maker and Dutch litmus-maker. Other species have recently been introduced, either as supplementary or substitutional species, such as *Umbilicaria pustulata, Parmelia perlata,* and *Lecanora pallescens* var. *parella.* For the purposes of British manufacture none of these are collected from the rocks of our own highlands and islands, but are procured from the African coasts and islands or the mountains of Norway, at a considerable expense; while there is reason to believe that many species possessing similar, if not equally valuable, colour-yielding properties, might be gathered at home at an infinitely cheaper rate. When the cudbear manufacture, which is now extinct in Scotland, flourished in Leith and Glasgow, large quantities of *Lecanora tartarea* were collected by the peasantry of the western highlands and islands; and the revival and extension of this traffic would probably prove a great boon to that

remnant of the Celtic race, which is fast disappearing from our shores to spend its energies in foreign climes. Under various vernacular names species of the same genera have for ages been employed by the peasantry of this and other countries, to yield pigments wherewith they dyed their yarn and home-spun fabrics. In Scotland, not many years ago, particularly in certain districts, almost every farm and cotter-house had its tank or barrel of "graith," or putrid urine (the form of ammoniacal liquid employed), and its "lit-pig," wherein the mistress of the household macerated some familiar "crottle" (the Scotch vernacular term for the dye-lichens in general), such as *Lecanora tartarea* or *Parmelia saxatilis*, and prepared therefrom a reddish or purplish dye. The commercial designation of the dye-lichens depends upon the thallus being erect or pendulous and cylindrical or shrubby on the one hand, and flat, crustaceous, or foliaceous on the other; species having a thallus of the former character being termed "weeds," as the *Roccellæ;* and of the latter "mosses," as the *Lecanoras* and *Parmelias*. The "weeds" chiefly used in the preparation of orchill, the *Roccellæ*, are popularly called "Orchella weeds," and are somewhat specifically arranged in commerce according to their geographical sources, as "Angola, Lima, Cape, or Canary Orchella weeds."



Vincent Brooks Imp.

The "mosses" are more irregularly designated, the specific name in some being due to their geographical source, as "Canary rock-moss;" in others, to their physical characters, as "Tartareous, or Pustulatous, moss."

We have spoken of colouring matters which are produced by the metamorphosis of colourless organic acids; but some Lichens possess brilliant yellow or greenish colouring matters, also of an acid nature, which exist ready formed in, and give the predominant tint to, the thallus of the plant. Such colouring matters are the *Vulpinic acid* of *Cornicularia vulpina*, and the *Parietinic acid* of the common yellow Wall Lichen (*Parmelia parietina*). From the purple colour which it strikes with alkalies, the latter acid has been proposed as a test for that class of bodies: it is also one of the colouring matters of medicinal rhubarb,—an interesting instance of the analogies, in composition and products, between the Lichens and phanerogamic plants. We may here further cite, as illustrations of these analogies, the occurrence of *fumaric* or paramaleic acid,—which is moreover producible artificially from malic or maleic acid, the sour principles of the apple and other acid fruits,—equally in *Cetraria Islandica* and *Fumaria officinalis*, the common Fumitory of our fields; of *oxalic* acid, in the form of various salts, equally

in many Lichens to a large extent, and in garden rhubarb, sorrel, and other phanerogams; and of an *oil* similar to the furfurol of bran and the fucusol of seaweeds, which is producible by distilling *Cetraria Islandica, Usnea barbata,* and other Lichens with certain proportions of sulphuric acid and water. Brownish colouring matters, ready formed in the thallus, also exist abundantly in many Lichens, and are easily extracted; they are the basis of various dyes prepared by the peasantry of this and other countries, but they are not of sufficient value ever to have been manufactured or applied on the large scale. It will thus be remarked that the only matters really valuable in dyeing are the product of the chemical metamorphosis of colourless compounds, which usually exist in species devoid of vivid or deep tints.

Lichens, in consequence chiefly of imaginary virtues, were at one time employed in various arts, in which their use is now totally abandoned. From their alleged aptitude for imbibing and retaining odours or scents, the powder of several filamentous and fruticulose species formed the basis of certain *perfumes* which were celebrated in the seventeenth century, and of which the chief was designated the "Poudre de Chypre" (*Pulvis Cyprius*), or Cyprian hair-powder: these were popularly believed to remove scurf, and to clean

and promote the growth of hair. The astringency of some species rendered them serviceable in *tanning* and *brewing*; the beer of a certain Siberian monastery, which at one time acquired a celebrity from its peculiar bitterness, owed this to *Sticta pulmonaria*. The gum of some species has been used in paper, pasteboard, and parchment-making, in weaving, and in calico-printing; and various dried species have been used instead of straw, or a similar material, in the packing, for transport, of furniture, fruit, etc.

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CHAPTER IV.

GEOGRAPHICAL DISTRIBUTION.

" 'Tis Nature's livery o'er the globe,
Where'er her wonders range."

" The living stains, which Nature's hand alone,
Profuse of life, pours forth upon the stone;
For ever growing; where the common eye
Can but the bare and rocky bed descry,—
There Science loves to trace her tribes minute,
The juiceless foliage and the tasteless fruit;
There she perceives them round the surface creep,
And while they meet their due distinctions keep,
Mix'd but not blended: each its name retains,
And these are Nature's ever-during stains."—CRABBE.

We shall consider briefly the geographical diffusion of Lichens, both horizontally, that is, from the Equator to the Poles, or in general over the earth's surface; and vertically, that is, from the base to the summits of mountains. The

vertical is, to a certain extent, a type of the horizontal range; for, in ascending the highest mountains of tropical countries, we find at their base the handsome foliaceous Lichens of warm climates, and at or below their snow-line the puny crustaceous species, characteristic of Arctic regions; while intermediate between these are to be met with types of most of the forms common to temperate countries. As bearing intimately on geographical range, we shall also here regard the subject of habitat. In the coldest as well as the hottest regions hitherto visited, and at the greatest elevations yet reached by man, Lichens have been found in greater or less abundance. They attain their maximum development in the form of large foliaceous Parmelias and Stictas in the tropics; but they also terminate, in the form of saxicolous Lecideas, the vegetation of the Arctic and Antarctic regions. Little Table Island—at the time of Parry's fourth voyage the most northern known land in the world—has its rocky sides "covered with abundance of very large Tripe de Roche, some Reindeer moss, and other Lichens;" while on Cockburn Island Dr. Hooker, who, in his magnificent works on the Cryptogamic Antarctic Flora, has made many valuable contributions to our knowledge of the geographical distribution of Lichens, found only Lecanoras, Lecideas, and a few

Mosses, constituting the last remnants of vegetation in the Southern Hemisphere. Some Lichens may be considered cosmopolites, such as our common *Lecanora subfusca, Cladonia pyxidata,* and *Usnea barbata.* From the evidence of travellers it would appear that there is a great similarity of species in different parts of the world. Robert Brown has shown that of New Holland Lichens two-thirds are natives also of Europe; Don has pronounced the majority of Himalayan Lichens to be identical with European species; and the same thing has been noticed in regard to those of South America by Humboldt, and of North America, the Arctic and Antarctic regions, by various authors. Many of our commonest British Lecanoras, Lecideas, Cetrarias, Cladonias, Parmelias, Peltigeras, Ramalinas, Sphærophorons, and Stereocaulons are to be found, according to Dr. Hooker, in the Falkland Islands, Graham's Land, Kerguelen's Land, and other islands or continents of the Antarctic regions; according to Royle, on the Himalayas; to Nylander, in Chili; to Martius, in equatorial Brazil and South America; to Parry and other Arctic voyagers, in Spitzbergen, Lapland, Iceland, Nova Zembla, and more northern polar islands or continents. In proportion as our knowledge of Lichenology becomes improved, and especially in proportion as we become ac-

quainted with the varieties producible in species by differences in the nature of the habitat, and by climatal and other changes, so shall we probably find the types of lichenose vegetation in different parts of the world more nearly similar. There is good reason to believe that, hitherto, many varieties of common species growing on foreign shores have been described by their discoverers as new species, or perhaps as the bases of new genera, from an ignorance of the epirrheology of Lichens,—of the causes productive of changes in form, colour, and general characters. In regard to Polar species, for instance, the peculiarities of climate, the protracted winter, the extreme dryness of the air, and the intensity of light, must be borne in mind; and it is but reasonable to suppose that British Lichens transferred to the climate of Ross's Islet or Kerguelen's Land, would undergo remarkable modifications in their characters, and in particular would probably become deformed, stunted, rigid, and sterile. The same climatal changes are in operation as we ascend high mountains, viz. the gradual diminution of temperature or increase of cold, diminution of moisture or increase of dryness of the atmosphere, and the increased intensity of the light. We have already seen that Lichens attain their maximum development in tropical regions; there

also they reach their maximum numbers. Mirbel states that, while in Spitzbergen, at latitude 80°, there are only about thirty species, in Madagascar, under the tropic of Capricorn, between latitudes 13° and 24°, there are no less than five thousand, thus showing the numerical relation of species to temperature and other climatal conditions. But the proportion of cryptogamic to phanerogamic vegetation increases on the other hand from the Equator to the Poles; for, while on equatorial plains it is as one to fifteen, and on equatorial mountains as one to five, in the temperate zone it is as one to two, and in the frigid zone as one to one; until the vegetation becomes wholly cryptogamic, thus illustrating the law that the simplest plants are most widely diffused over our globe. There is probably a similar, though not so high a proportion, between Lichens and other cryptogams in their longitudinal diffusion, though this has never been accurately determined. In taking a survey of the horizontal range of lichenose vegetation over the world, it is found, on the other hand, that in particular countries or hemispheres certain species, genera, or families have only a limited diffusion, or attain only a minimum development. The Umbilicarias, which are very common in Arctic regions, are represented by a single species in the Antarctic, where they

are replaced by Stictas, which again are rare in Arctic islands or continents. Tuckerman mentions the absence of *Physcia prunastri*, a very common British species, from North America; and Dr. Hooker notices the scarcity in the Southern Hemisphere of some species which are common in the northern, and the abundance of some in the southern extreme of the Western Hemisphere, which are entirely absent from a similar position in the Eastern. Certain species again are peculiar to the Antarctic regions, such as the *Sphærophoron australe*, which is confined in its geographical range to the Straits of Magellan.

On the highest mountains, between the region of shrubby alpine plants and the snow-line, or between an elevation of 13,000 and 16,000 feet, there is a terminal zone of vegetation, denominated the region or zone of Lichens. In regard to vertical range on a tropical mountain, the Lichens may therefore be said to form the base as well as the apex of a cone, whose sides may be considered as covered with every tribe of the vegetable kingdom, from the proudest of the Palm family to the tiniest Moss. On the central and southern Alps the highest limit of phanerogamic plants occurs at an elevation of about 10,000 Paris feet. But species of *Parmelia, Lecidea,* and *Umbilicaria* are found on all the rocks

projecting through the snow, without any limitation as to height, and ascending far above the snow-line; they also occur at above 16,000 feet on Chimborazo. Among the species found at the greatest elevations hitherto reached by man, none is more common than the familiar *Lecidea geographica;* it occurs far above the line of perpetual snow on the Alps, and is the last type of vegetation met with on the Andes and Himalayas, and on the deserts of Nova Zembla.

The chief *habitats* of Lichens are the bark of trees, rocks or stones, and the soil; but they likewise grow frequently on the decayed stumps or rotten hollows of old trees, on wooden palings, shrubs, mosses and Jungermanniæ, perennial or evergreen leaves, the mortar of walls, and sometimes on the thallus of other species. Of *corticolous* species, some are characteristic of the rugged bark of old trees, as various Parmelias, Ramalinas, or Stictas; others prefer the smooth bark of young trees, as many of the *Graphideæ,* which are also frequently to be found on the smoothest stems of shrubs. Some Lichens are to be found chiefly on trees, such as the ash or oak, which grow on the sides of public highways, as *Parmelia parietina, P. stellaris, P. pulverulenta,* and *P. olivacea*; others occur only or chiefly in our forests, as *Usnea barbata, Sticta pulmonaria,* and various

Graphideæ. The rotten stumps of old trees are the favourite haunt of many Caliciums and Cladonias; while to wooden palings a few Lecanoras and Parmelias are peculiar. Some species are peculiar to certain trees. In the trees yielding cinchona and other medicinal barks so much is this the case, that a celebrated French author has proposed classifying them according to the Lichens growing on their surface. It has moreover been stated that the portions of these valuable barks covered by Lichens abound in the peculiar chemical principles on which their medicinal use depends, while portions covered by Fungi are valueless, from the tissue being destroyed by their ramifying mycelium. This circumstance has been held corroborative of the belief that Lichens are not destructive of the bark of trees on which they grow, as Fungi undoubtedly are; an opinion which does not seem however fully borne out by other facts. A few Lichens inhabit decayed herbaceous plants, as a form of *Lecanora tartarea,* which sometimes incrusts common heather; others grow on moss, as various Lecideas and Collemas; the *Strigula Babingtonii* coats the leaf of the common Box and Laurel; and the genera *Abrothallus, Scutula,* and a few others, are parasitic on the thallus of various common species. Of *saxicolous* Lichens, some are peculiar

to calcareous rocks, as *Urceolaria calcarea, Gyalecta cupularis, Lecidea calcarea* and *immersa;* a few are chiefly found on arenaceous rocks, as *Lecanora atra,* and the saxicolous forms of *Lecidea aurantiaca;* many are common on the granitoid series, including therein micaceous, gneissic, granitic, and quartzose rocks, as *Lecanora tartarea* and *ventosa, Parmelia conspersa* and *Fahlunensis,* and many *Lecideæ;* and *Lecidea geographica* is frequent on the purest and smoothest quartz. The student who gives attention to this subject will soon observe that, while Lichens are abundant on sandstone and granitic rocks in Scotland,—on the former in lowland, on the latter in alpine regions,—they are comparatively rare on the basalt series. The nature of the habitat appears to exercise an influence distinct from that of climate; for we have found granitoid boulders lying at a slight elevation above the sea, in trap and sandstone districts, covered with subalpine or alpine Lichens. Schimper describes the sandstone of the Vosges, which produces a sandy soil, as having a richer lichenose vegetation than that of Alsace, which gives rise to a clayey marl. On mountains it is frequently easy to determine that Lichens, especially crustaceous species, exist in greater abundance and perfection in situations exposed to the north and west. Of Lichens which

grow on the soil or ground some *Cladoniæ* and *Lecideæ*, as *L. æruginosa, uliginosa,* and *granulosa,* prefer moist peaty soil; *Lecidea decipiens* and *lurida,* calcareous soil; some *Stereocaula,* siliceous; the Peltigeras and some Bæomyces, argillaceous; while *Peltigera venosa* and some Collemas grow on hardened mud. The mineralogical characters or chemical composition of the soil or rocks on which Lichens grow undoubtedly have much influence on their development, which also depends greatly, in many cases, on their physical properties, such as their aptitude for absorbing and retaining heat and moisture. Calcareous soils are much more rapidly heated than argillaceous ones; hence the former are called by French agriculturists "terres chaudes," while the latter are contradistinguished by the appellation "terres froides." In this way authors have sought to account for the fact that, in northern latitudes, Lichens are usually saxicolous—rocks most rapidly absorbing the sun's heat—while in tropical countries they are corticolous, the foliage of trees forming a protection from its scorching rays. Several species are peculiar to the rocks of our sea-coasts, such as the Roccellas, *Lichinæ,* certain Opegraphas, *Ramalina scopulorum,* and *Verrucaria maura;* many are found only in low-land regions, as *Parmelia parietina, P. olivacea,* and *Per-*

tusaria communis; others are common in subalpine districts, on hills of minor elevation, as *Lecanora tartarea* and *ventosa, Cladonia rangiferina, Cetraria Islandica* and *aculeata;* while a few are essentially alpine, and characteristic of the summits of our highest mountains, as the Umbilicarias, some Cladonias and Lecideas, *Peltigera venosa, Parmelia Fahlunensis,* and others. There, luxuriating in the moisture of the dense mists in which they are almost constantly bathed, many species attain a high state of development, and some of them, great beauty, as the *Solorina crocea;* of this any tourist may convince himself by clambering to the summit of Ben Lomond or Ben Nevis. While certain species are found chiefly or solely on trees, rocks, or the ground, others, under different circumstances of locality or climate, may be indiscriminately corticolous, saxicolous, or terricolous; or species which inhabit rocks in one country or climate may be found on trees in another. With such changes in the nature of the habitat, however, it is but reasonable to expect corresponding alterations in the characters of the plants: hence we frequently find the fructification altered, —a Lichen which is fertile when growing on a tree becoming sterile on a rock, or *vice versâ.*

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CHAPTER V.

COLLECTION, PRESERVATION, AND EXAMINATION.

"How sweet to muse upon His skill display'd
(Infinite skill!) in all that He has made;
To trace in Nature's most minute design
The signature and stamp of *power* divine!"

We again repeat, that for the collection and preservation of Lichens no costly or complex apparatus, no profundity of botanical skill, no high degree of manipulative ingenuity are requisite; though, for the examination of their minute anatomy, especially that of the Reproductive system, it is necessary that the student be familiar with the use of the microscope. It is uncalled-for here to reiterate the advantages of studying the Lichens in their living state with a view to a knowledge of the variations of species; nor is it necessary, after what we have said under the head of habitat

—here to specify the localities that ought to be searched by the collector. Every roadside wall, every mountain rock or boulder, every sea-side cliff, will furnish to him inexhaustible materials. The timber brought into our wood-yards, the fallen twigs of Firs and other forest-trees collected as firewood, the ballast of our ships, our ancient architectural ruins, will each be found the habitat of an infinity of interesting species. Not only this; but with a view to a careful study of their origin, development, and decay, Lichens may be sown and cultivated. A few years ago the raising from seed of such plants as Lichens, Mosses, Fungi, or Algæ, would not even have been conceived possible; now it is a reality. It appears that Lichens are now being cultivated with great intelligence and success in the Jardin des Plantes of Paris; and in various parts of France considerable attention is now being devoted to the cultivation of others of the lower cryptogams,—a circumstance full of significance, as showing the gradual development of the belief that the interest of a study cannot be held proportionate to the size of the objects of research,—that a knowledge of the embryology or organology of the simplest plants is a necessary prelude or key to that of higher vegetables, and that cryptogams cannot be properly examined unless in the living state.



W.J. Linsley del. Roth.lith.

Vincent Brooks Imp.

Filamentous and fruticulose species may be readily separated from the surfaces on which they grow at their point of adhesion; they may then be dried by exposure to the air or sun, and packed in small boxes, such as pill-boxes; or they may be steeped in water, subsequently dried between towels, and then subjected to pressure between folds of bibulous paper, as is done in the preparation of herbarium specimens of phanerogamous plants. The latter mode is the most elegant; by it the plant may be cleansed, its segments tastefully displayed, and so flattened by pressure as to admit of its being fastened by gum or glue to paper or cardboard. This mode is however only suitable for the species of certain genera, such as *Usnea*, *Cornicularia*, *Ramalina*, *Physcia*, *Cetraria*, *Collema*, and some *Parmelias*. To separate some foliaceous species from their base of support the assistance of an old flat knife or similar instrument is necessary. Steeping in water is in some cases attended with this disadvantage, that it alters the characters of the thallus or apothecia; the red colour of the apothecia of certain Cladonias is by this means changed to a dull brown. Some species, such as the Cladonias and *Calicia*, may be collected in clusters, like tufts of moss, with portions of the soil or decayed wood on which they usually grow; they may then

be allowed to dry spontaneously, subsequently fastened to pieces of cardboard, and arranged in shallow drawers, like eggs or shells,—or they may be kept in small pasteboard trays similarly arranged, or packed in thin paper, like minerals. In the case of the Cladonias, also, the individual plants may be detached, steeped in water, dried, and compressed, like fruticulose and filamentous species. Many species adhere so intimately to, or are so incorporated with, their base of support, that it is impossible to separate them, and it then becomes necessary to remove with them a portion of the latter: such are the Lecideas, Verrucarias, Graphideæ, and many Lecanoras. In the case of corticolous species a portion of the bark must be removed by the knife, and ought to be dressed on the spot into a neat and convenient form. For saxicolous Lichens the geological hammer is called to our aid, and the portion of the rock removed should be dressed, and subsequently preserved, according to the rules observed in the collection and conservation of mineralogical and geological specimens. Corticolous and saxicolous species, which cannot be detached from their base of support, are probably best arranged on cardboard in trays, or packed in paper as above mentioned. In whatever way arranged, it is advisable, so far as possible, to select speci-

mens which will exhibit the fertile and sterile conditions of the plant,—both surfaces of the thallus, varieties depending on differences of habitat,—and monstrosities, if any.*

The *use of various chemical reagents* is a most important auxiliary to the examination of the tissues of Lichens under the microscope. One class of chemical substances is useful on account of the colour which they strike with the cellulose, amylaceous, and other matters of which the constituent cells of these tissues are composed, or which they contain; the other, from their power of dissociating certain elements of these tissues which are intimately united—of rendering distinct the outlines and structure of various delicate and transparent cells, and of coagulating their contents. Of the former class the most useful reagent is *Iodine,* in the form of the ordinary tincture of the druggist; of the latter, *Sulphuric* and other mineral acids: without their aid the student will frequently fail to discover certain elements or tissues, which are either very delicate and transparent or very minute and colourless. We should

* The student cannot satisfactorily examine the external characters of the thallus and its fructification without the aid of a simple pocket-lens, which may be had at any optician's, for one or two shillings.—For directions as to the application of the compound microscope, we must refer the uninitiated to works treating of the construction and uses of that most valuable instrument.

therefore advise him, especially in his earlier microscopic investigations, to accept the aid of Iodine and Sulphuric acid as types of the two classes of reagents above mentioned. To illustrate their action and uses it may be here advisable to glance briefly at a few of the more prominent physico-chemical characters of the Lichen-tissues and their constituent elements. When applied to certain elements of the reproductive tissues, the peculiar reaction of iodine with starch is at once produced; they immediately assume a rich Prussian-blue colour: such is the case especially with the theca. The iodine ought to be very diluted, and one drop added on the glass slide to the tissue under examination should suffice, for the very deep colour of the tincture of iodine may obscure delicate shades of blue, and otherwise interfere with the reaction or result produced. The theca is most deeply coloured at its apex, where it is thickest. The spore-sac and its contents, whether in the condition of a grumous or granular protoplasm, or developed into spores, are usually tinged orange or yellow; and the theca, full of mature sporidia, after the application of iodine, is thus a very beautiful object under the microscope. The blue colour of the theca is sometimes so deep, especially in its young state, and the pale-yellow of its contents so obscured

or destroyed thereby, that the latter may also appear blue; or the yellow colour of the contents, shining through the transparent blue thecal membrane, may sometimes cause these to assume a green tint. If iodine be applied to an apothecium entire or sectioned, in consequence of this peculiar reaction it is frequently possible to distinguish the thecæ by the naked eye in the form of a congeries of deep blue lines or points; in some cases so abundant are the thecæ that the whole apothecium at once becomes blue. By this means also the spore-sac is sometimes rendered visible as a yellowish delicate membrane lining the theca. The spores are generally coloured yellow, their outline and contents rendered more distinct, and the latter, especially in the old state, frequently coagulated and broken up. The hypothecial tissue in most Lichens is also tinged blue. The walls of the paraphyses, with the exception of the terminal cell, which remains unaltered, appear of a very pale blue, if the iodine is sufficiently dilute; more usually this colour is destroyed by that of the iodine, and they appear yellow; their walls are more distinct, their septa become evident, and their contents are coagulated and form an irregular core or centre in the long axis of each constituent cell. The spermatia are rendered more distinct by being coloured

deep brown. The contents of the filaments of the medullary layer of the thallus are coagulated, as in the paraphyses; and in the other cell-elements of the thallus little change is produced, save a greater distinctness of their walls and contents. There are various exceptions to, and anomalies in, the reactions above given; but they will be found to hold good in the majority of common Lichens. The action of iodine on the reproductive cells of Lichens, in the examination of which it is chiefly useful, ought to be studied in species having comparatively large or distinct thecæ and spores, such as *Pertusaria communis* and *Physcia ciliaris*. The mineral acids are chiefly useful for dissociating the thecæ and paraphyses, and enabling the student to examine their true structure and attachments. He will also find it convenient sometimes to boil portions of a Lichen, to facilitate the making of a section or to produce a disaggregation of its tissues.

CHAPTER VI.

CLASSIFICATION.

"Without system the field of Nature would be a pathless wilderness."
WHITE, *of Selborne.*

IN regard to their position in the scale of vegetation, Lichens belong to the thallogenous (thallus or frond-bearing) or cellular division of Cryptogamic plants; they are destitute of a vascular system, consisting, as we have seen, entirely of various forms of cellular tissue. By their reproductive system they are closely allied to the Fungi; by their vegetative system, to the Algæ; from both they are distinguished by the presence of gonidia as an essential element of their thallus. So close are the links which bind the Lichens to the allied families of the Algæ and Fungi, that Algologists and Fungologists are constantly removing certain genera or species from the Lichens; while Lichenologists are on the other hand engaged in swelling the ranks of the Lichens at the expense of the Algæ or Fungi. Thus

the genera *Lichina* and *Collema* hold an anomalous position in regard to the Algæ, in which some botanists classify them; while *Bæomyces* and other genera occupy a similar debatable relation to the Fungi. Lichens may also be said to be connected with the Mosses by the transition-group of the Hepaticæ,—of which the common *Marchantia*, or Liverwort, a denizen of the damp, dark sides of rocks in the neighbourhood of streams or waterfalls, is a familiar example.

After what we have said on the subject of the bases of Classification, when describing the history of Lichenology in our first Chapter, we need make no apology or justification for preferring, in the following arrangement of British species, a natural to an artificial classification—a classification founded on natural affinities or structural analogies, rather than one based on the vegetative or reproductive system of Lichens exclusively. We cannot advance a complete natural system of classification; nor can this be done until our knowledge of the natural history of the Lichens is greatly improved and extended. We consider the distinctive marks of Lichen-species to be at present very imperfect and unsatisfactory; many genera and species stand in a most anomalous position in regard to their alliances, and the progress of Lichenology must soon result in a complete revolution in the classification and nomenclature of

British Lichens. Under these circumstances we think it preferable only to describe the characters of typical and familiar species, believing that an enumeration even of the mere names of rare species and puzzling varieties would serve only to confound and alarm the beginner, for whom this little work is chiefly intended.

In our arrangement and description of most of the *Gymnocarpous* Lichens, or those in which the thalamium is typically open, we have followed Schærer's 'Enumeratio critica Lichenum Europæorum' (Berne, 1850); and in those of the *Angiocarpi*, or Lichens in which the thalamium is typically closed, as well as of the Gymnocarpous Natural Order *Graphideæ*, Leighton's 'British Species of Angiocarpous Lichens elucidated by their Sporidia' (Ray Society, London, 1851) and his 'Monograph on the British Graphideæ' (Annals of Natural History, London, 1854). On these valuable contributions to Lichenology the descriptive part of this Work is mainly founded; to their pages we must refer all desirous of prosecuting the subject beyond its mere skeleton or outlines.* We are also under deep obligations to the memoir

* To this statement it may be advisable to add the following qualification,—that we do not regard the classification in these works as at all approaching perfection; there are many points on which we differ materially from their authors. They are however the most recent works on their respective subjects, and contain comparatively the greatest amount of correct information.

of Tulasne, already cited, for almost all that we know of the spermogones and pycnides, the spermatia and stylospores, of Lichens, and of certain minute parasitic species, whose true nature and structure he has been the first to point out; and also for much valuable information regarding the minute anatomy of Lichens. Great assistance has also been derived from the elaborate descriptions of Fries ('Lichenographia Europæa reformata,' 1831), as given by Tuckerman in his 'Synopsis of the Lichenes of New England, the other Northern States, and British America' (Cambridge, U.S. 1848). We have preserved, in the following descriptions, the terminology of Schærer and Leighton, both because it economizes space, and serves to convey a much more accurate idea of the organisms intended to be described, than any popular or general language we could employ. The student may overcome any etymological difficulties by having recourse to a Latin or Greek dictionary. We avoid however, with a view to simplify the study of British Lichens to the beginner, giving any synonyms or references excepting those which relate to the 'English Botany' of Sowerby (1756)—for nearly a century a standard work on British Botany, and which contains plates of all the British Lichens then known.

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SYNOPSIS OF THE NATURAL ORDERS AND GENERA.

I. GYMNOCARPI.

(According to Schærer.)

Nat. Ord. I. USNEACEÆ.
- Genus 1. USNEA.

II. CORNICULARIACEÆ.
- 1. CORNICULARIA.
- 2. ROCCELLA.
- 3. RAMALINA.
- 4. PHYSCIA.

III. CETRARIACEÆ.
- 1. CETRARIA.

IV. PELTIDEACEÆ.
- 1. NEPHROMA.
- 2. PELTIGERA.

3. Solorina.
V. Umbilicariaceæ.
1. Umbilicaria.
VI. Parmeliaceæ.
1. Sticta.
2. Parmelia.
VII. Lecanoreaceæ.
1. Lecanora.
2. Urceolaria.
VIII. Lecideaceæ.
1. Gyalecta.
2. Lecidea.
IX. Graphideaceæ,
(According to Leighton.)
1. Opegrapha.
2. Graphis.
3. Hymenodecton.
4. Chiographa.
5. Aulacographa.
6. Lecanactis.
7. Platygramma.
8. Arthonia.
9. Coniocarpon.
X. Caliciaceæ.
1. Calicium.
2. Coniocybe.
XI. Cladoniaceæ.
1. Stereocaulon.
2. Bæomyces.
3. Cladonia.
XII. Collemaceæ.
1. Collema.

II. ANGIOCARPI.

(According to Leighton.)

Nat. Ord. I. Sphærophoraceæ.
Genus 1. Sphærophoron.
II. Endocarpaceæ.
1. Endocarpon.
2. Sagedia.
3. Chiodecton.
4. Pertusaria.
5. Thelotrema.
III. Verrucariaceæ.
1. Segestrella.
2. Verrucaria.
IV. Limboriaceæ.
1. Pyrenothea.
2. Strigula.

Section I. GYMNOCARPI.

Nat. Ord. I. *USNEACEÆ.**

Family Character.—Thallus filamentous: filaments round, having a cartilaginous or leathery cortical layer, which is very liable to crack and separate in annular fragments from a central thread of white, cottony, medullary tissue,—giving the thalline filaments a peculiar articulated and sometimes a moniliform appearance. *Apothecium* peltate, terminal on the thalline filaments, which appear as if dilated at their extremities into a flattened, somewhat irregularly rounded disc; margin radiate-ciliate, pale flesh-coloured, or colour similar to that of thallus.

Genus I. USNEA, *Dill.*

Name said to be derived from the Arab *Achnêh* or *Achnen* (*Axneeh* or *Usnee* according to Dillen), a generic term for all Lichens.

* The student will derive much assistance from examining named and dried specimens of British or foreign species as contained in the following works:—Leighton, Lichenes Britannici exsiccati, 1851, published in fasciculi, of which several have appeared: Bohler's Lichenes Britannici: Schærer, Lichenes Helvetici exsiccati, 24 fasciculi, last dated 1852: Mougeot and Nestler, Stirpes Cryptogamicæ Vogeso-Rhenanæ, 10 fasciculi, 1813, last dated 1833: Tuckerman, Lichenes Americæ Septentrionalis exsiccati, 2 fasciculi, 1847: Fries, Lichenes Suecici exsiccati: Massolongo, Lichenes Italici exsicc.

1. USNEA BARBATA (*barba*, a beard). Thallus greyish-green or straw-coloured, frequently, in young state, erect, rigid, and somewhat fruticulose, becoming with age flaccid and pendulous; dense cortical tissue of thallus consists of roundish or polyhedral, thick-walled cells; thecæ small, oboval; spores minute, round, oblong or oval-oblong, double-walled, pale yellow or colourless.—The following varieties of this common species depend chiefly on the number, and mode of ramification, of the cylindrical branches of the thallus.

Var. *florida;* divaricate-ramose, rigid, erect, smooth, fibrillose. A subvariety, *hirta*, is characterized by a verrucose or pulverulent condition of the filaments (E. B. 1354).*

Var. *ceratina* differs in being pendulous; it may be smooth or verrucose-pulverulent, fibrillose or not.

Var. *plicata;* pale straw-coloured, elongated, subdichotomous, flaccid, and slender.

Var. *dasypoga* differs chiefly in the main branches being covered with horizontally divergent fibrils.

Var. *articulata* is a prostrate or pendulous form, characterized by much stronger, broader branches, which are divided into a series of turgid articulations,—frequently

* The initials represent Sowerby's 'English Botany,' and the number refers to the figure and relative description of the species.

appearing as if hollow and inflated,—and connected by a narrow but firm white medullary thread. Another variety has been denominated *intestiniformis*, from the resemblance of the turgid articulated branches to inflated intestines: this we cannot help regarding as a finical subdivision.

This species is very common on our older forest-trees, especially firs, coating them with a shaggy grey fleece. Along with various Ramalinas, Cornicularias, and Physcias, it constitutes the "Beard-moss" or "Tree-moss" of the poets,—the "idle moss" of Shakspeare. Poets usually refer to filamentous and fruticulose corticolous Lichens as "Moss;" hence they speak expressively of venerable trees being "mossed with age." In this sense the branches and stems of the trees in the fir-woods which are common in this neighbourhood (Perth) are completely "mossed" over. Branches thus adorned are usually selected for the purposes of the bird-stuffer, and must be familiar to all who have seen collections of stuffed birds in public or private museums. It is very widely distributed over the world. In India it is one of the most common species; it has also been found in Ceylon; on Chimborazo, and in Chili, in South America; in New Holland; as far south as New Zealand and Tasmania; and as far north as Lapland. It is said to be re-

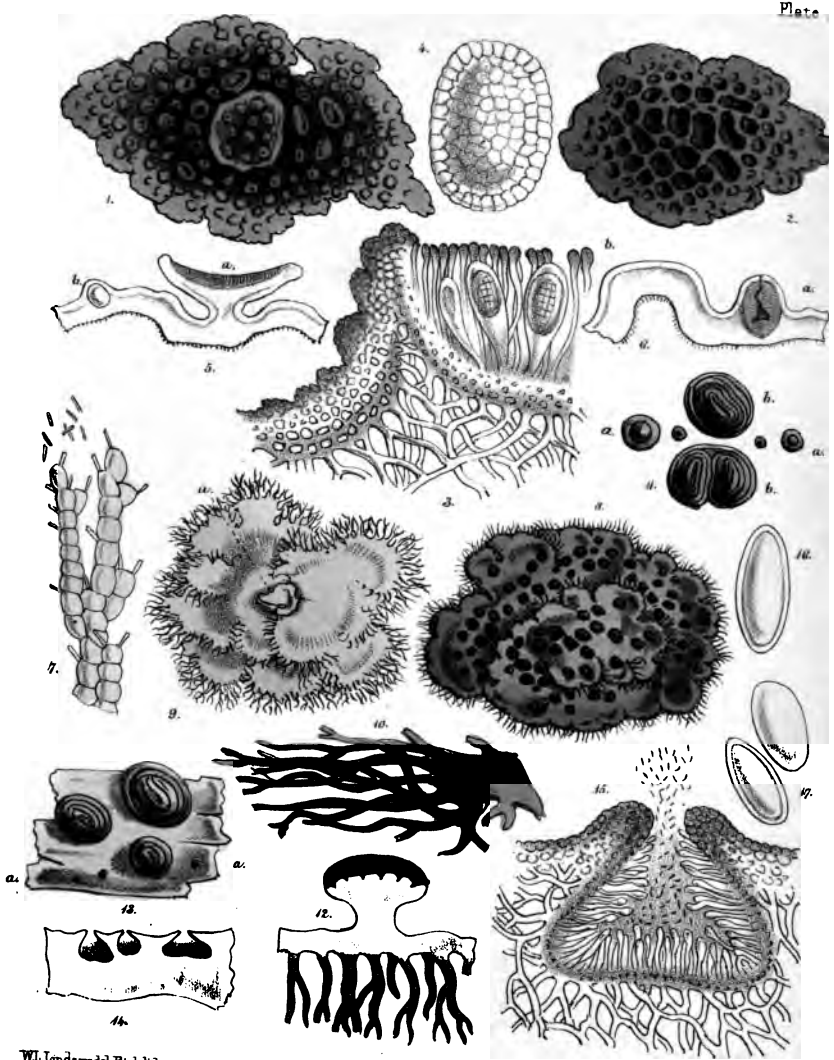
placed in the Arctic and Antarctic regions by another species, *Usnea melaxantha,* which is interesting in a threefold point of view, but which may be considered a variety of *U. barbata* peculiar to a polar climate. It is one of the most handsome and arborescent Lichens, closely assimilating them to the *Phanerogamia.* Its cross section exhibits a structure resembling, on superficial examination, that of an exogenous stem, having a distinct axis and a separable cortical layer; and it is the only saxicolous species, for in the Falkland Islands, Dr. Hooker says, it covers "the surface of the quartz rocks with a miniature forest, seeking the most exposed situations, and there attaining its greatest size and beauty." Some varieties of *U. barbata* have a more limited geographical range than others: var. *florida,* for instance, is inferior in this respect to var. *plicata;* this is to be expected, when we consider that these varieties must depend greatly on differences in habitat and climate. What we now regard as varieties were by the older authors considered distinct species; but they are frequently found graduating into each other in such a way, that it is impossible to determine under which form or name to arrange them, and several of them may be met with growing in the same forest, nay on the same tree. Of all the forms the most

remarkable is that denominated var. *articulata;* it is said sometimes to be pendulous from old trees: our own specimens were prostrate, spreading over the sandy soil of Exmouth Downs; they are from the herbarium of Don. It differs from the others no less in the breadth and inflated character of the nodes, or articulation, into which its filaments are divided, than in its size; we have seen specimens attaining about two feet in one direction and one in the other. It has been familiarly termed *par excellence* the "Necklace Moss," but this name has probably been more commonly applied to less rare varieties, in which annular decortication is also frequent. The economical applications of *U. barbata* are not important, but they are numerous and varied. In some parts of the world it is eaten by wild animals, or is collected and preserved as winter fodder for domestic animals. Bartram states that in Pennsylvania it has been used to yield an orange dye, and Humboldt mentions its use as a dye species in South America. It appears to have enjoyed great celebrity in medicine, though certainly not from any real advantages which it possesses; it was at one time much used as an astringent, tonic, and diuretic; it became a favourite remedy in hooping-cough, and under the name of "Muscus arborei, seu querni," was

even lauded as an anodyne! It was the basis of some hair-powders and perfumes, and was also supposed to possess qualities which rendered it serviceable in the manufacture of detonating or combustible mixtures. Ray states that it was boiled in beer and drunk in catarrh and dropsy; the Laplanders have used it in scald-head and other eruptions in children; and so early as the times of Dioscorides it is said to have been prescribed in diseases of females. Its central medullary thread has been recommended in paper-making; but even in these times, when substitutes for linen rags and flax fabrics in the manufacture of paper have become matters of necessity, we fear such a substance will not be thought of by experimentalists, for one reason alone, that it contains no fibrous tissue. (For the minute anatomy and development of this species, *vide* Dr. Speerschneider in the 'Botanische Zeitung' for March 24 and 31, and April 7, 1854.)

Nat. Ord. II. *CORNICULARIACEÆ.*

Fam. Char.—*Thallus* filamentous or linear-laciniate, ascending or pendulous. *Apothecium* scutellate, varying in site and colour. (Name probably from *corniculum*, a little horn.)



W.L. Landsay del. Pitch lith.

Genus I. CORNICULARIA, *Schreb.*

Gen. Char. Thallus terete-compressed or linear-laciniate, lacunose, everywhere of similar colour, having a cartilaginous cortical layer; apothecium subpedicellate, terminal or axillary.

1. CORNICULARIA JUBATA (*juba*, a horse's mane). Thallus brownish or greyish, usually pendulous, terete or sub-lacunose, dichotomously and much branched; filaments elongated and entangled, sometimes bearing whitish soredia; apothecia brown, or of same colour with thallus.

The following are comparatively well-marked varieties:—

Var. *bicolor;* so called from the extremities of the thalline filaments being pale-coloured; it is fruticulose, rigid, and divaricate-ramose. (E. B. 1853.)

Var. *chalybeiformis* is a prostrate form, chiefly growing on alpine rocks; sub-rigid and flexuose. (E. B. 1880.)

But the most common forms, viz. vars. *prolixa* and *cana*, are flaccid and filiform, much branched and entangled, and pendulous from our forest-trees, especially the fir. They are called, from their resemblance, "Tree or Rock Hair," or the "Horse-tail Lichen." The old generic name, *Alectoria*, was derived from the Greek word for hair. They are comparatively common in lowland and sub-alpine woods, and frequently trail down the surface of trees to the length

of one or two feet; their apothecia however are not very frequently met with, and from their small size and having a similar colour to the thallus they are apt to be overlooked. In mountain and moorland regions they occur not unfrequently on rocks, as on the Cheviots and Grampians, but they are always in such circumstances inferior in size, and more rigid. The variety *bicolor* is peculiar to alpine rocks; it occurs in various parts of our Highlands, as in the neighbourhoods of Loch Tay and Braemar, but is seldom found in fructification. *C. jubata* has a wide geographical range, extending as far north as Ross's Islet and and Little Table Island in the Arctic regions. Its thecæ are small, narrowly oboval, eight-spored; its spores are minute, ellipsoid-oval or roundish, colourless, double-walled. It would appear to possess a certain amount of nutrient properties, being frequently eaten in winter by the Lapland reindeer as a substitute for the *Cladonia rangiferina:* to enable these useful animals to feed on it with less difficulty, the Laplanders cut down the firs on which it grows. It is said also to be capable of yielding a red dye; we have not found it to exhibit any colorific properties, but we have frequently noticed the paper in old herbariums stained red or orange by various Cornicularias, especially some North

American species. Some foreign species appear, in a slight degree, to possess nutrient and demulcent properties, but none have been used to any extent in medicine or the arts.

2. CORNICULARIA OCHROLEUCA (*ochra*, ochre, and λευκός, white). Thallus ochroleucous or pale, terete-compressed, sub-lacunose, divaricate-ramose; extremities of the ramules sub-fibrillose; apothecia chestnut-coloured.

Var. *cincinnata*; thallus much branched, entangled, somewhat rigid, deeply ochroleucous; extremities of ramules not differing in colour. (E. B. 2040.)

There is a rigid fruticulose form, in which the apices of the ramules are reflexed and blackish; and it occurs also in a pendulous filiform condition, growing on trees along with *Usnea barbata*. This species is alpine, and may be met with, on the ground, on the summits of several of our highest Highland mountains, such as Cairngorm. It is also found in Europe as far north as the Arctic regions, for instance on Ross's Islet.

3. CORNICULARIA FLAVICANS (*flavus*, bright yellow). Thallus golden-yellow, terete-compressed or linear, divaricate-ramose, filiform, and fibrillose; old thallus sometimes becomes white and roughened by soredia; apothecia orange-coloured. (E. B. 2113.)

It grows on the trunks of old trees, and also sometimes on rocks or the ground; it has been mentioned as occurring on the south coast of England, on the Malvern Hills, and on Ailsa Craig in the Firth of Clyde, but it is a rare species in Britain. Its cortical layer is very dense, consisting of almost solid, cylindrical filaments very closely united: iodine communicates to it a rich blue colour. It is the seat of a beautiful yellow colouring matter, probably similar to that of the following species, and has apparently been similarly employed in dyeing.

4. CORNICULARIA VULPINA (*vulpes*, a fox). Thallus citron-coloured, divaricate-ramose, linear; extremities filiform; surface sometimes pulverulent or sorediiferous; apothecia chestnut-coloured or blackish, but very rare.

Its habitat is the bark of fir-trees in alpine or sub-alpine regions; but it appears only recently to have been recognized as a native of Britain, having been found on the Killeney Hills, county Dublin, Ireland. It possesses a very dense, horny cortical layer, of which the cellular elements can scarcely be recognized; and also a firm central axis or cylinder, formed of solid filaments closely associated. Its cortical layer contains, disseminated through it in the form of small grains of a resinoid appearance, a beautiful

colouring matter, called *vulpinic acid,* which is easily extracted by various solvents, and has been used in Sweden and Norway to dye woollen stuffs. The Swedes call this species "Ulf-mossa" (Wolf's-moss), from a belief that it is poisonous to wolves; this is very problematical, but certain it is that it is used as a poison to these animals: Pontoppidan states that the bait is usually the carcase of some animal smeared and stuffed with a mixture of this Lichen in a powdered state, and pounded glass.

Genus II. ROCCELLA, *DC.*

Gen. Char. Thallus fruticulose, segments springing from a common base, round or thong-like, equal or nodulose, erect or pendulous, glaucous, everywhere of similar colour, having a cartilaginous cortical layer: very frequently sorediiferous. Apothecium scutellate, its exciple being innate in the thallus, normally lateral. Thalamium at first covered by a thalline veil, afterwards naked, black.

Generic term derived from the Portuguese word *rocha,* a rock, in allusion to the habitat of most of the species; or from the name of the family of the Florentine merchant (Oricellarii, or Rucellai) who was the first to manufacture from them the now familiar dye *Orchill.*

1. ROCCELLA TINCTORIA (*tinctura*, a colour or dye). Thallus round, at length nodulose or warted; segments simple or bifurcate, naked or sorediiferous; old thallus frequently becomes much elongated, pendulous or trailing, rarely branched; apothecia lateral. (E. B. 211.)

Its spermogones are frequently absent; when present they are readily recognized as black points scattered over the whitish thallus. They are globular, unilocular, and immersed; their spermatia are linear and feebly curved. There is considerable variety in the form of the apothecia. Sometimes they are regularly patellate, resembling the apothecia of *Lecidea;* at other times they are misshapen tubercles, appearing to have burst through the cortical layer, which forms around them an irregular thalline exciple; the latter state is the more usual, but is probably an abnormal condition of the former. The spores of both are alike, being ellipsoid-oblong, straight or slightly curved, generally quadrilocular or triseptate, nearly colourless or pale yellow, resembling somewhat those of *Peltigera* and *Sticta.* Its habitat is maritime rocks; it grows to a very limited extent on the Isle of Portland, Guernsey, and other points on or near the south coast of England. It is more abundant on the Mediterranean shores, but reaches its maximum deve-

lopment only in tropical or warm climates, where however it has a somewhat wide geographical range.

2. ROCCELLA FUCIFORMIS (*fucus*, a species of seaweed). Thallus flattened or thong-like, irregularly divided, often fan-shaped; segments variously bent, naked or sorediiferous; apothecia lateral and superficial.

It grows, like the preceding species, chiefly on maritime rocks; but in some foreign countries it is found also on trees, as at Pondicherry, in India, where its habitat is the trunk of the *Mangifera Indica*. It occurs very sparingly on the south coast of England, in the Channel Islands, and on the adjacent islands and coasts of France. But it is only in tropical Africa, Asia, and South America, that it reaches its highest development; on the coasts of these countries it frequently attains great size, and has a very tough leathery consistence. It usually has a greater abundance of apothecia, and is more seldom warted or mealy, but more frequently cracked and fissured, than *R. tinctoria*. Its colour is generally tawny or ochroleucous, and it varies much in the size and mode of division of its laciniæ. Its geographical range is greater than that of the preceding species. *R. tinctoria* and *R. fuciformis* may be considered types of the most valuable dye-species of the genus *Roccella* which we

possess,—the "Orchella weeds" of commerce, which are divisible botanically into three classes:—1. Such as have a cylindrical tapering thallus; 2. those having a flattened or compressed thallus; and 3. a mixture of the two preceding forms. Of the first class the chief varieties are "Canary," "Barbary, or Mogador," "thick Lima," and "Cape" Orchella weeds; while of the second the principal are the "Angola," "Madagascar," and "thin Lima" weeds. Of these the most valuable kind at present is the Angola weed, from the Portuguese settlement of Angola, in South Africa; it is about an inch and a half to two inches in length. The Canary variety, which includes the "Cape de Verde weed" from the Canary, Cape de Verde, and adjacent islands off the west coast of Northern Africa, has been the longest known in commerce; it is a delicate filiform species about half an inch to an inch and a half long, and frequently of a dark brownish colour. Next to these the Lima varieties, from the west coast of South America, are greatly used by the orchill-maker. The thick form is frequently six to eight inches long, with thick tough segments, sometimes superior in diameter to a goose-quill; it usually occurs in the form of fragments having a reddish cross section. The thin variety has the characters described under *R. fuciformis*. The

Cape, Barbary or Mogador, and Madagascar forms are inferior in size and quality. Besides *R. tinctoria* and *R. fuciformis*, and the varieties *hypomecha* of the former and *linearis* of the latter, the chief botanical sources of these Orchella weeds are *R. Montagnei*, *R. pygmæa*, *R. flaccida*, *R. phycopsis*, and *R. dichotoma*. Comparatively numerous as are their geographical sources, many new and probably superior fields of export remain to be opened up to British commercial enterprise; in illustration of which we need only cite the vast fields of India and the Indian Archipelago, the shores of Africa and Asia bordering on the Red Sea, New Zealand, New South Wales, and many of the Pacific Islands. The Roccellas grow abundantly on the arid rocks of Aden, in Arabia; and the Indian and Ceylon specimens which we have seen are remarkable for their great size.* The production of an export trade in dye-lichens might not only prove a boon to the poor inhabitants of many a hitherto barren shore, but would probably become remunerative to British manufacturers who are at present paying high prices for the Angola weed and similar fine varieties of Orchella-weed, which are fast becoming scarce

* Vide Paper by the Author in the 'Edinburgh New Philosophical Journal,' July, 1855, on the "Dyeing Properties of Lichens."

in the market. Plants growing in arid situations in tropical countries are found richest in colorific principles; hence, as compared with species from tropical Africa, Asia, or South America, European species are worthless in commerce. Burnett illustrates this, by stating £290 per ton as the value of Canary Orchella-weed, while the same plant from Madeira will only bring £140, and from Barbary from £30 to £45, in the market. This is an instructive lesson on the influence of climate in the production of changes in the chemical composition or products of Lichens. The estimated annual value of the imports of Orchella-weeds and other dye-lichens many years ago was stated at £60,000 to £80,000. Their value has been gradually rising in the English market. Half a century ago only inferior kinds were procured at prices ranging from £20 to £200 per ton; now very fine qualities are imported from various localities, probably at an average price of £200 to £400; and they have been known to rise so high as £1000 per ton. While Italy enjoyed a monopoly in the manufacture of Orchill, large quantities were supplied by Teneriffe, the Canaries, Azores, and neighbouring islands; the inhabitants farmed out the right to gather the Orchella-weeds, paying therefor considerable sums to the Government. Prior to this the Orchella-weeds were known only in the

islands and shores of the Levant; and their capability of yielding, by maceration in ammonia, a purple dye, was accidentally discovered by a Florentine merchant travelling there, who noticed that putrid urine tinged the plants red or purple. Returning home, he founded on the hint thus obtained the manufacture of Orchill, which he long carried on with great secrecy under the name of "Tournesol," and by which he realized a handsome fortune.

R. tinctoria possesses emollient or demulcent properties, and hence has been used to allay the tickling cough of phthisis and in other chest affections; these qualities depend on the presence of a certain amount of starchy and gummy matters. It contains, moreover, according to Nees von Esenbeck, resin, wax, and glutinous matter, tartrate and oxalate of lime, and chloride of sodium, the latter probably due to adherent sea-water. Its ash contains lime, soda, magnesia, alumina, silica, and peroxide of iron, in combination with carbonic, sulphuric, and phosphoric acids.

Genus III. RAMALINA, *Ach.*

Gen. Char. Thallus fruticulose, segments arising from a com-

mon base, linear-laciniate, glaucous, lacunose on both sides, everywhere of similar colour, having a cartilaginous cortical layer, frequently sorediiferous, originally erect, frequently pendulous. Apothecium scutellate, subpedicellate, varying in site. Thalamium always naked, of similar colour to thallus, or pale flesh-coloured. (Name derived from *ramale*, a dead twig, probably in allusion to a very common habitat of its species.)

1. RAMALINA POLLINARIA (*pollen*, fine flour or meal). Thallus flaccid, lacero-laciniate; laciniæ flattened, sub-lacunose; soredia somewhat large, usually scattered; apothecia sub-terminal. (E. B. 1607.)

Habitat: the trunks of trees and wooden palings, in or about lowland and sub-alpine woods; but it is a comparatively rare species in Britain.

2. RAMALINA FARINACEA (*farina*, meal or flour). Thallus flaccid, somewhat smooth and shining, multifid-laciniate; laciniæ linear-attenuate, flattened; soredia small, white, fimbriate; apothecia terminal and lateral, but very rare. (E. B. 889.)

A very common species, growing on our forest-trees and hedges. We see no reason for dissociating it from the following species, of which it appears to constitute a frequent form, and along with whose varieties it may often be met with on the same habitat.

3. RAMALINA FRAXINEA (*fraxinus*, the ash-tree). Thallus rigid, shining, reticulate-lacunose, variously laciniated, very rarely sorediiferous; apothecia vary in site. There are three comparatively well-marked varieties.

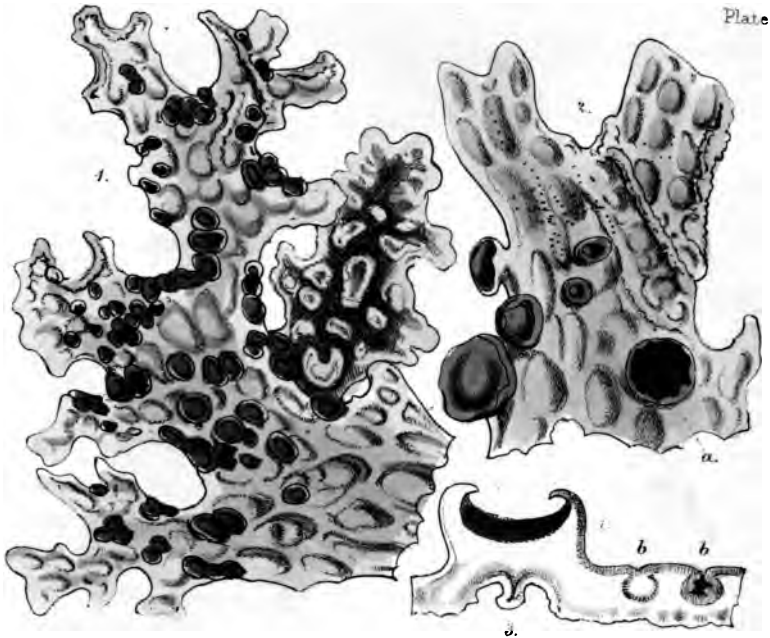
Var. *ampliata;* characterized by the breadth and size of the laciniæ, which are flattened and somewhat simple, and by the apothecia being lateral and superficial.

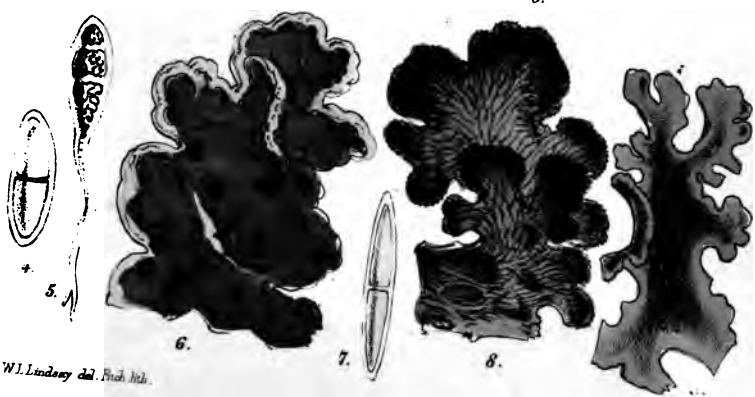
Var. *fastigiata;* distinguished by the apothecia being terminal, and the laciniæ, which are shorter and narrower, fastigiate. (E. B. 890.)

Var. *calicaris* differs considerably from the others in the tenuity of its laciniæ, which are linear, elongated, dichotomously ramose, canaliculate, ribbed or smooth; apothecia terminal, spurred and seated on the deflexed apices of the laciniæ.

This species is one of the most common Lichens, growing on trees and hedges in our forests and on our roadsides. Of its varieties the last is the least frequent; but all of them, along with the preceding species, frequently grow on the same tree or hedge, and pass by insensible gradations into each other. The oak and ash are probably the most common habitats of the larger forms. Less frequently it grows on rocks, but in this case it is always somewhat dwarfed,

rigid, and altered in form. *R. farinacea* differs from var. *calicaris* only in the constant presence of soredia, and in the smoother or more flattened character of the laciniæ; we look upon it as a sorediiferous form of this filiform variety of *R. fraxinea*. The spores of this species are of medium size, and easily recognizable; they are somewhat oval-elongated, rounded at the ends, straight or curved to various degrees, bilocular or uniseptate, of a very pale yellow or colourless. The young spore is oval and full of grumous or finely granular protoplasm. In course of development there appears at either end a globular aggregation of largish granules, which increase in size, then disappear into a homogeneous mass; this gradually acquires a membrane, and lastly assumes the form and characters of one of the loculaments or secondary cells of the spore. In the old state of the spore these contained cellules again break up into a confused granular mass; and it is in this state also that the curved form of the spore is most common. In all the species or varieties of British Ramalinas which we have examined we have found the spores having the same characters, differing only in size, according to habitat. This we consider another strong argument for the identity of species; for, with Fries, we are inclined to regard all the British Ramalinas as forms





W.L. Lindsay del. Finch lith.

of a single species, *R. fraxinea*. The thecæ are somewhat elongated, eight-spored, and exhibit the blue discoloration with iodine. The spermogones (as occurring on var. *calicaris*) are to be looked for with a lens on the ramifying venules of the thalline laciniæ, in the form of small, isolated, obtuse tubercles, having a similar colour to the thallus, and which closely resemble in general appearance the young apothecia. They are globular or ellipsoid, and consist of a dense whitish tissue, which contrasts strongly with the loose, spongy circumjacent medullary tissue; the cavity is simple; the sterigmata delicate, simple, straight filaments closely crowded; the spermatia acrogenous and straight. The cavity of the spermogone contains, in addition to the sterigmata, a network of loose branching filaments, inferior in thickness, but otherwise similar to the medullary tubes.

This species has a wide geographical range; it occurs abundantly on the Himalayas and in different parts of the Indian Peninsula. Species of the genus *Ramalina* appear to be scattered all over the world, within the limits of 60° north and 57° south latitude, and they extend as far north as Lapland in Europe and the Polar regions in North America (Dr. Hooker). The Ramalinas contain a considerable amount of gum, which has been used instead of gum-

arabic in calico-printing and in the making of parchment and pasteboard; in a pulverized form they have been used as the basis of hair-powders. Some forms, especially the mealy Ramalina, *R. farinacea*, have been recommended as edible, and as palatable when eaten with salt. The same species has been recently lauded as a topical application for chilblains and chapped hands; but its virtues probably depend more on the presence of spirit of wine or hartshorn in the lotion for the former, and of honey, yolk of egg, brandy, and sweet oil in that for the latter troublesome affection.*

4. RAMALINA SCOPULORUM (*scopulus*, a rock or cliff). Thallus rigid, polished, smoothish or striate-lacunose, linear-laciniate or terete, very seldom sorediiferous, often attaining a great size; apothecia large, terminal and lateral. (E. B. 688.)

This is a coarse, rigid, deformed variety, peculiar to, and common on, the rocks of our sea-coasts; it frequently forms a shaggy coating on the cliffs of many of our rugged shores and islands, where it sometimes reaches the length of six

* Speerschneider, Mikroskopisch-anatomische Untersuchung über *Ramalina calicaris*, Fr., und deren Varietäten *fraxinea*, *fastigiata*, *canaliculata* und *farinacea*, 'Botanische Zeitung,' May 18, 1855.

to twelve inches. From the Isle of May in the Firth of Forth we have seen it in abundant fructification, of great size and very tough, leathery consistence; while in various other localities we have gathered it plentifully in a delicate filiform state; between these conditions there is every variety of form and size. The cortical layer is extremely dense and horny; and, being devoid of distinct cellular structure, it appears like a hardened epidermiform excretion on the surface of the plant. The medullary filaments towards the periphery have very thick walls, the central canal being nearly obliterated; in the centre they have more of their ordinary characters. Its spermogones are frequently so numerous as to roughen the thalline laciniæ with the little tubercles of which they consist. Each of these has a central blackish point —the ostiole; its cavity is almost spherical, but divided into several compartments; the spermatia are acrogenous and oblong. These spermogones are liable to be confounded with the perithecia of a small, black, punctiform Fungus, or with the spot-like rudiments of a minute *Sphæria*. This species has a somewhat wide geographical range, and occurs as far south as the Falkland Islands and Kerguelen's Land. It has been used to yield a red dye; so high an opinion did Lightfoot form of its tinctorial qualities, that he spoke of it

as a formidable rival to the *Roccellæ*. *R. farinacea* has also been said to possess similar colorific properties.

Genus IV. PHYSCIA, *Schreb.*

Gen. Char. Thallus linear-laciniate, membranaceous; lower surface of laciniæ canaliculate, and differing in colour from upper surface. Apothecium scutellate, subpedicellate, terminal or lateral. Thalamium always naked, varying in colour, and differing in colour from the thallus.

1. PHYSCIA FURFURACEA (*furfur*, bran or scurf). Laciniæ,—above greyish, furfuraceous (covered with a bran-like dust),—below channeled, coal-black, reticulate-lacunose,—becoming attenuated from a broadish base, loosely sinuate-pinnatifid, naked at margins; in old plants laciniæ become broadened and irregular, and are roughened with minute granular isidioid or scale-like growths; apothecium normally terminal; thalamium chestnut-coloured; margin thin, entire.

It grows on trees and rocks in subalpine woods, but is not very common; we have met with it frequently on firs in the hill woods round Perth, but never in fructification. We have seen large specimens, and in fine fruit, from Rothiemurchus Woods, and from the Andes. It is found abun-

dantly on the Himalayas, and in many other parts of the world. From containing a considerable quantity of a bitter principle, it has been used as a febrifuge instead of cinchona bark or quinine. We have found it yield, on ammoniacal maceration, a red dye. The Egyptians at one time employed it in the baking of bread, as a substitute for another species, *P. prunastri;* and it has been used also in the making of hair-powders.

2. PHYSCIA CILIARIS (*cilium*, the hairs of the eyelids). Laciniæ subascending,—above brownish-green or glaucous, pubescent,—whitish and slightly reticulate-lacunose below, —linear, divaricate-ramose, ciliate at margins, subcartilaginous; apothecium varies in site; thalamium blackish, subpruinose; margin erect, afterwards lacerate-dentate, fimbriate, or passing into foliaceous growths.

A somewhat elegant and common species, growing on trees, rocks, and stones in lowland and subalpine regions; in this neighbourhood we have found it attaining considerable size and beauty on roadside walls. This species possesses great interest, as having been the first Lichen in which the existence of spermogones was, a few years ago, discovered and recorded by Itzigsohn in Germany.* They

* *Vide* various papers in the 'Botanische Zeitung' for 1850 and 1851.

are scattered over the laciniæ of the thallus in the form of blackish or brownish point-like prominences, whose apices under a lens exhibit pores or chink-like apertures; their tissue is horny and dense, admitting of division into very thin sections. The sterigmata are short, straight, narrow, obtuse, and obscurely articulated; the spermatia cylindrical, straight, obtuse at the ends, and very transparent, generated laterally from the sterigmata. The cavity of the spermogone is divided into several convergent sinuses. The black-punctate condition of the thalline laciniæ has long been familiar to lichenographers, but has usually been supposed due to parasitic organisms, and as such these spermogones have been described by various authors as *Sphæria Lichenum* or *Endocarpon athallum*. This is an excellent species in which to study the form and development of the thecæ and spores, and the reaction of iodine thereon. In the young state the thecæ are elliptic-oblong, but when full of spores they become broadly obovate, tapering suddenly inferiorly into a narrow pedicle; they are comparatively large, distinct, and are eight-spored.* The mature spores

* For the minute anatomy of this species *vide* Von Holle, zur Entwickelungsgeschichte der *Physcia ciliaris*, Göttingen, 1849, and 'Botanische Zeitung,' July 25, 1851; and Dr. Speerschneider in the 'Botanische Zeitung,' Oct. 7 and 14, 1853; Aug. 25, and Sept. 1 and 8, 1854.

have somewhat the form of the figure 8, being composed of two large rounded cells, in apposition by one surface: they are of a dark brownish or olive-green colour, and have three coats, the outer being the wall of the primary cell or epispore; the two inner belong to the secondary or contained cellules. The young spores are oval, and full of granular and mucous matter; gradually this becomes divided into two distinct portions by a central septum, and ultimately the bi-cellular condition is produced. This species is also common on the Himalayas, and has been found in other parts of the world.

3. PHYSCIA PRUNASTRI (*prunus*, a plum-tree). Laciniæ flaccid, membranaceous,—above glaucous, reticulate-lacunose,—below white,—linear, divaricate-ramose; apices acuminate; apothecia lateral; thalamium chestnut-coloured; margin thin, entire. (E. B. 859.) There is a sorediiferous and a black-punctate form, the latter being var. *stictocera*. (E. B. 1353.)

A very common species, pendent on trees and palings in lowland and subalpine districts; it is extremely abundant on firs in the hill-woods round Perth, coating them with a shaggy beard of grey; but we have only twice found it in fructification. It is very apt to be mistaken for, or con-

founded with *Ramalina fraxinea*, with which it frequently grows, but from which it may readily be distinguished by the flaccid, pendent thallus and the white colour of the under side of the laciniæ. In some localities it occurs chiefly in a dwarfed, deformed, and very sorediiferous state; in such a condition we have found it abundant in the woods around Floors Castle, Kelso.* It sometimes grows also on stones and rocks, and even in a prostrate state on the ground: of a trailing form of the variety *stictocera* we have large specimens from Exmouth Downs,—the same locality where grows the peculiar articulated variety of *Usnea barbata*. This species yields a gum, which was introduced experimentally into Glasgow, as a substitute for gum-arabic in calico-printing, by the late Lord Dundonald, but soon fell into disuse. On account of this property also it has been used as a demulcent in chest-complaints. From its giving a peculiar and much-relished flavour to bread, it was at one time much used in baking in Egypt; for this purpose, Forskuel says, it was imported in shiploads from

* The ash of this sorediiferous variety was found by Mr. Wallace Lindsay to contain the bases potash, soda, lime, magnesia, alumina, peroxide of iron, and manganese, in combination with sulphuric, hydrochloric, and phosphoric acids.

the Archipelago into Alexandria: a handful was steeped for two hours in water, and the infusion added to the bread. We have found it yield, on ammoniacal maceration, a fine orchill. From the capacity of its powder to absorb and retain odours, it was long greatly used in perfumery.

4. PHYSCIA CHRYSOPHTHALMA (χρυσός, gold, and ὀφθαλμός, the eye). Laciniæ,—above yellowish or orange,—below white, lacunose,—linear, ascending, dichotomously ramose; extremities dilacerate or ciliate; apothecium varies in site; thalamium orange; margin thin, naked, or ciliate-radiate.

A very beautiful corticolous species, growing in the form of a small fruticulose tuft. In Britain it is a very rare species; we have seen specimens in abundant and fine fructification from Switzerland. Its thecæ and spores resemble those of *Parmelia parietina*.

P. intricata and *P. leucomelas* (λευκός, white, and μέλας, black) (E. B. 2548) are also very rare in Britain, occurring only in a few localities. The former differs from *P. ciliaris* in its laciniæ being naked at the margins, the thalamium of the apothecium not pruinose, and its margin very entire. The latter more closely resembles the same species, but the laciniæ are narrow and ascending, and the cilia or marginal fibres very long, black, and tomentose.

Nat. Ord. III. *CETRARIACEÆ.*

Fam. Char. Thallus foliaceous or sub-fistulose, prostrate, ascending or erect, cartilaginous or membranaceous, generally reticulate-lacunose. *Apothecium* peltate, affixed obliquely and anteriorly to the apices of thalline lobules.

The Cetrarias may be considered intermediate between Lichens having a fruticulose, ascending thallus, and those having a foliaceous, horizontal one: hence the sub-fistulose thallus, which is somewhat analogous to the hollow podetium, approximates a certain section to the *Cladoniæ*, as *C. Islandica*, *C. aculeata*, and *C. nivalis*; while certain others, such as *C. glauca* and *C. juniperina*, closely resemble the Parmelias in the nature of their vegetative system.

Genus I. CETRARIA, *Ach.*

Name derived from *καίτρεα*, *cetra* or *cætra*, an ancient shield of a peculiar form, which the apothecia are supposed to resemble.

1. CETRARIA GLAUCA (*glaucus*, greyish-blue). Thallus foliaceous, membranaceous, prostrate,—above glaucous, slightly reticulate-lacunose,—below brownish-black or variegated with white, smooth,—sinuate-laciniate; fertile laciniæ ascending; apothecia dark brownish-red, terminal.

In the common form (E. B. 1606) the under surface of the thallus is dark, and the fertile laciniæ shortened; in the variety *fallax* the former is variegated brown and white, and the latter elongated. (E. B. 2373.)

A common species, growing on trees, the ground and stones in and about lowland and subalpine woods; it is however very rarely found in fructification. In Scotland it has been discovered fertile near Inverary by Maughan; we have seen large specimens abundantly fertile from North America. Compared with some other Cetrarias it is not very widely diffused over the globe. It is common in Northern and Central Europe and in Sub-arctic America, and is found as far south as the Alps and the Canary Islands, but not further north than Lapland.

2. CETRARIA JUNIPERINA (*juniperus*, the juniper-tree) is a smaller form, distinguished by its beautiful gamboge-yellow colour; thallus sinuate-lacerate-lacinulate; margins usually crisped; apothecia have a thalline crenulate margin.

In the common form the thalline margin is naked, and usually denticulate; in the variety *pinastri* it is covered with a yellow powder (sorediiferous) and simple.

An alpine or subalpine species, growing on the ground, on shrubs, and on trees. In Scotland it occurs on the

elm, fir, and other trees in some of our Highland forests; it is however seldom or never met with in fructification in Britain, though it is not unfrequently found fertile in Switzerland. Its thecæ are small; its spores small, oval or globular, colourless, and double-walled, resembling those of *Usnea* and *Cornicularia*. It yields readily to boiling water and other solvents a beautiful yellow colouring matter, which has been employed in domestic dyeing by the Swedes. It once enjoyed celebrity as a specific in jaundice, probably on the *similia similibus* principle, from some fancied connection between its colour and that of the skin in this troublesome disease.

3. CETRARIA NIVALIS (*nix, nivis*, snow). Thallus straw-coloured on both sides, frequently of a deep yellow at the base, ascending, membranaceo-cartilaginous, deeply reticulate-lacunose or channeled, sinuate-lacerate-lacinulate; margins crisped, sometimes black-denticulate; surface of thallus sometimes sprinkled over with white soredia. Apothecia (which are very rare) yellowish-flesh-coloured, terminal, having a thalline, crenulate margin. (E. B. 1994.)

A somewhat common alpine and subalpine species, growing on the ground on the summits of our Highland mountains, such as Ben Lawers and Cairngorm. In Britain it

is never fertile; but we have seen large specimens in beautiful fructification from Labrador, Newfoundland, and the Arctic regions, where it has been found as far north as Walden Island and Ross's Islet. Its cortical tissue is dense and horny, composed of polyhedral, thick-walled cellules; it is the seat of a resinoid, yellow, finely granular colouring matter. Like *C. Islandica*, but in a minor degree, it is nutrient, demulcent, and tonic. In northern countries it is frequently eaten by goats and other animals, notwithstanding the hardness and rigidity of the thallus.

4. CETRARIA SEPINCOLA (*sepes*, a hedge or fence). Somewhat resembles *C. glauca*, growing chiefly on the branches and trunks of trees in alpine and subalpine woods; thallus brownish, paler below, prostrate, sinuate-lacinulate; laciniæ flat, with smooth margins, sometimes crisped or pulverulent. Apothecia (which are very rare) terminal, having a thalline, crenulate margin, sometimes entirely covering the thallus.

We have never met with fertile British specimens, but have seen it in fine fructification from Newfoundland and other parts of North America.

5. CETRARIA ISLANDICA. Thallus chestnut-coloured, exterior paler, and marked by wart-like white spots, inner surface smooth, frequently blood-red at base, cartilaginous,

erect, by dichotomous division sinuate-laciniate, margins connivent, ciliate-spinulose; apothecia chestnut-coloured, terminal or subterminal, usually affixed anteriorly to broadened, shortened, rounded lobules, having a thalline, entire or crenulate margin.

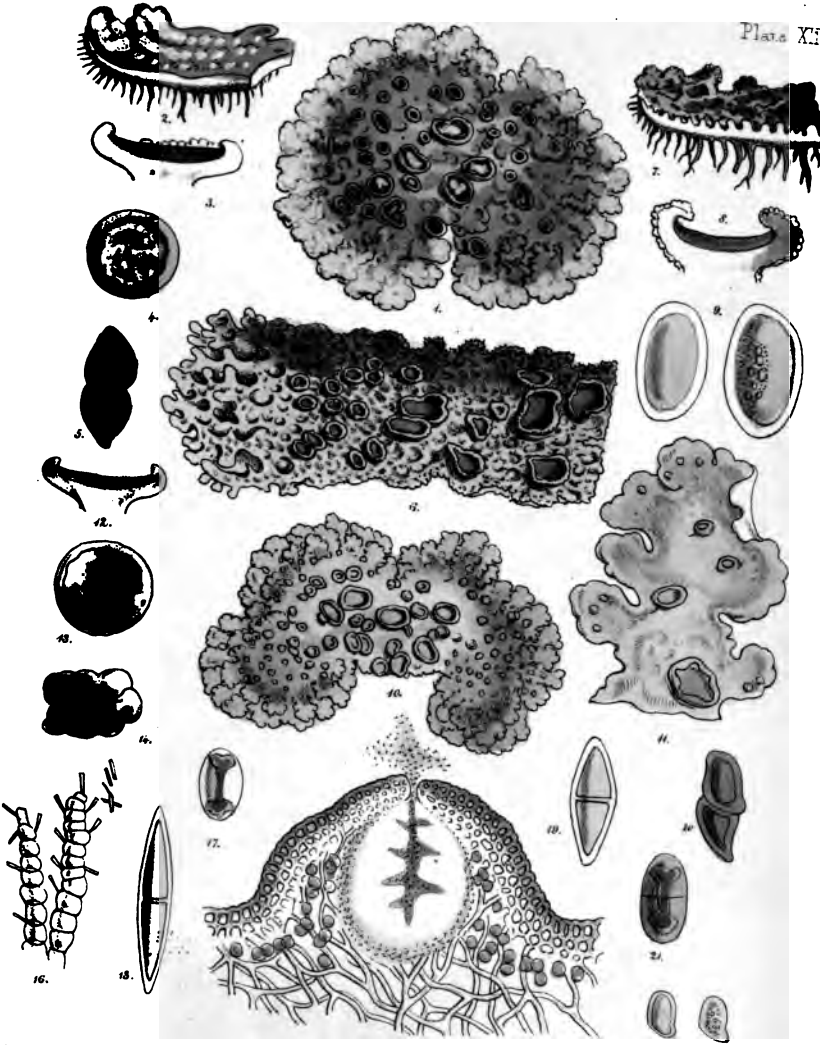
In the common variety the sterile laciniæ are sublinear and channeled: the laciniæ are sometimes very broad, flattened or waved, with naked or crisped edges.

This species, the familiar "Iceland Moss," is essentially alpine and subalpine in its habitat, growing abundantly on the ground on most of our higher Highland mountains, as well as more sparingly on the Lammermuirs, Pentlands, and other mountain-ranges of minor elevation. It is however seldom or never found in the fertile state in British specimens, or in the commercial Lichen, which is chiefly imported from Norway. It developes its fructification only on very high mountains or in very cold regions, for it has a comparatively wide range in Arctic and Antarctic climates; its fruit may be seen in Mougeot and Nestler's valuable collection of Vosges Cryptogams published some years ago ('Stirpes Cryptogamicæ Vogeso-Rhenanæ'). Its vertical range on the Scotch hills and mountains varies from 1500 to 4000 feet; it thus descends to a comparatively low

level; but, in general, its presence is indicative of a very cold climate. In the Arctic Circle it is found at the sea-level, and it grows on the bleak steppes of Central Russia, Asia, and North America; but as it spreads southwards it climbs the mountains. Its brown colour and the beautiful blood-red stains frequently found at its base are ingeniously ascribed by Schnedermann to various salts formed, with ammonia absorbed from the air, or with iron taken up from the soil, by *Cetraric acid*,—the peculiar bitter principle which resides in the cortical layer of the plant. With ammonia this acid forms a yellow salt, whose solution in water becomes *brown* on exposure to the air; and the cetrarate of ammonia, thus formed, causes a red reaction with persalts of iron. The composition and products of Iceland-moss have been studied by several chemists, who have detected in it starch to the extent, according to Berzelius, of 80 per cent., including both Lichenin and Inuline; gummy and waxy matters, the former also to a considerable extent; a bitter principle, *cetraric acid;* a fatty principle, *lichestearic acid* (λειχήν, lichen, and στέαρ, fat); *fumaric acid*, which exists also in the common garden fumitory (*Fumaria officinalis*); *gallic acid*, the astringent principle of galls; uncrystallizable sugar; and various salts, such as the bitartrate of potash,

and the tartrate and phosphate of lime. Its ash, according to the analysis of Mr. Wallace Lindsay, contains the bases lime, potash, soda, magnesia, and peroxide of iron, in combination with sulphuric, hydrochloric, and phosphoric acids. Its thecæ are short, small, and closely crowded in the thalamium; the spores are minute, oval, simple, colourless, and intermediate in size between those of *Cornicularia* and *Cladonia*. The spermogones are seated on the apices of the rigid marginal cilia, whose function appears normally to bear these organs, but which are frequently sterile. The spermogones are solitary or grouped in twos or threes; the spermatia linear and straight.

On the presence of a large amount of starch chiefly depends the extensive use of this Lichen in northern countries as an article of food, and in medicine as a nutrient, demulcent, and tonic. When boiled in water, it yields a tolerably firm jelly, which however contains some of the bitter principle of the plant, giving it not only a disagreeable taste, but a purgative quality. This can be removed by previously steeping the plant in a weak solution of carbonate of potash or soda; and the jelly prepared from the Lichen thus purified, when mixed with wines, sugar, or spices, or flavoured with various aromatic substances, is a very



W. Lindsay del. Fitch lith.

agreeable form of pudding of the blanc-mange or Irish Moss class. In this form chiefly it is used in this country by dyspeptics and invalids labouring under various chest-diseases, or suffering from chronic exhausting ailments; it constitutes a light and easily digested article of diet, and is employed instead of arrowroot *et hoc genus omne.* The Icelanders use it in a similar way, and also boiled in milk, whey, and soup. Proust found 1 lb. of Lichen sufficient to convert into a tremulous jelly, on cooling, 8 lbs. of soup. In the making of broth in Iceland it frequently serves the same purpose as our ordinary kitchen vegetables. Sir George Mackenzie, in his travels in Iceland, found it very palatable in chocolate; and other travellers mention an agreeable mixture made with sugar, lemon-peel, and butter or oil. The Icelanders frequently reduce it to powder, and preserve it for winter use, in the form of bread, porridge, or gruel, as we do meal or flour; or they clean and wash, dry, and chop it into small pieces. Not only do they make use of it themselves, but they store it up as fodder for their cattle and domestic animals. In so many ways indeed is it important in the domestic economy of the poor Icelanders, that they declare with a fervent gratitude "a bountiful Providence sends them bread out of the very stones."

In various parts of Scandinavia it is used by the peasantry, especially for the fattening of swine, oxen and horses. From a real or supposed capacity for retaining moisture, its gum or mucilage has been preferred in Germany to common paste for dressing the warp of webs in the loom; and it has likewise been used in the sizing of paper. Its bitter principle renders it purgative, a quality severely felt by Sir John Franklin and his companions in some of their Arctic voyages, they being frequently scarcely able to eat this nutritious Lichen, though in a state approaching starvation. This purgative property is greatest in the fresh plant, becoming deteriorated by drying; hence the Icelanders were at one time in the habit of using the fresh plant as an evacuant in spring. It has been recommended as a valuable antiscorbutic in countries where it is abundant. Petersen states that the Iceland scurvy, a kind of elephantiasis, is rare where the inhabitants consume in their food much of this Lichen or other vegetables, and common where, on the other hand, they use chiefly sour milk and rancid fish. From its astringency, which is due to the presence of gallic acid, it has likewise been used in tanning. Moreover it has, at various times, enjoyed celebrity in the treatment of a multitude of diseases; but its virtues have either been imaginary, or

have depended on the medicines with which it was combined. Its medicinal properties were probably first recognized in Iceland, and were known to Danish apothecaries so early as 1673. In 1683 Hiärne lauds it in the hæmoptysis, or blood-spitting of phthisis. It is still imported in comparatively large quantities into Britain *viâ* Hamburg and Gottenburg; in 1836 no less than 20,000 lbs. paid duty. It might be extensively gathered for commercial purposes on our Scotch mountains. And, lastly, the brown colouring-matter of its thallus has been applied by the Icelanders to the dyeing of woollen stuffs.*

6. CETRARIA ACULEATA (*aculeus*, a prickle). Thallus somewhat fruticulose, rigid, chestnut-coloured, cartilaginous, dichotomously or irregularly and very much branched; laciniæ divaricate, terete or flattened, smooth or roughish, stellulate or bifurcate at extremities; apothecia chestnut-coloured, terminal, having a thalline, ciliate-denticulate margin.

A comparatively common species growing on the ground,

* Cramer, De Usu Lichenis Islandici, Erlangen, 1780: Ebeling, de Quassia et Cetraria Islandica, Glasgow, 1779: Davidson on removal of bitter taste and lichenous odour of Iceland Moss, 'Jameson's Journal,' 1840: and Transact. of Edin. Soc. of Arts, June 20, 1838: Proust in Journal de Physique, vol. iii.

on the tops of hills of minor elevation, such as the Pentlands, in the vicinity of Edinburgh, or the hills surounding Perth, but occurring more abundantly on the Highland mountains. It frequently grows along with the preceding species, with narrow or linear forms of which it may be confounded. Like most of the preceding species, it is not common in fructification; we have found it fertile however on the summit of the Pentlands. Its spermogones are oval or oval-truncate bodies, which constitute the blackish apices of the terminal spinules or ramuscles of the laciniæ. In position and appearance they resemble the spermogones of *Cladonia rangiferina* and other Cladonias.

CETRARIA CUCULLATA (*cucullus*, a hood) closely resembles in habit *C. nivalis*, with which it is usually found growing, but is distinguished by its apothecia being affixed posteriorly to the hood-shaped extremities of the thalline lobules. It has recently been noticed as a British species, but is very rare; it is an alpine plant, growing on ground on the highest mountains, or in Arctic countries, to which in Europe it is chiefly confined. Like *C. Islandica*, we have seen specimens with a beautiful purple mottling or discoloration at the base of the thallus, which would seem to indicate the existence in it of colorific principles.

Nat. Ord. IV. *PELTIDEACEÆ.*

Fam. Char. Thallus foliaceous, coriaceous or membranaceous, prostrate or ascending, laciniate-lobate, below tomentose or veined, affixed to base of support loosely or interruptedly by fibrils. *Apothecium* peltate, affixed horizontally or vertically to thalline lobes.

Genus I. NEPHROMA, *Ach.*

Gen. Char. Thallus somewhat villous below; apothecium reniform, affixed to under side of produced and ascending extremities of thalline lobules; thalamium always naked. (Name from νεφρός, the kidneys.)

This genus has much the habit of *Peltigera*, but is easily distinguished by the form and position of the apothecium.

1. NEPHROMA RESUPINATUM (so called from the fruit being placed at the back of the thallus, facing downwards: *resupino*, to turn upside down). Thallus glaucous or brownish,—below paler, and somewhat tomentose or naked,—prostrate; laciniæ minute, multi-lobular; lobes rounded, subcrenate; apothecia chestnut-coloured, largeish. (E. B. 305 is a tomentose form.) The thallus is sometimes sorediiferous. (E. B. 2360.)

A subalpine species, growing on the ground, on rocks

and on the trunks and roots of trees on the shores of Loch Lomond and Loch Fine, in Breadalbane, and similar Highland districts; in many of these localities it is found in abundant fructification. This species has a superior and inferior cortical layer, the former being dense and leathery, formed of superimposed rows of polyhedral cells very intimately united; the latter thinner, and formed of more irregular cell-elements. The medullary filaments are almost solid, the central canal very narrow, and the septa remote and thickened. Its spermogones occur on the margin of the thallus in the form of small, smooth, brownish tubercles, with an apical pore or ostiole; spermatia linear, very slightly curved, resembling in tenuity those of *Cetraria* and *Cladonia*. Its thecæ are elongated and eight-spored; the spores closely packed, apparently in a spiral manner, fusiform, blunted at ends, polyseptate, very pale yellow or colourless. Some species of *Nephroma* occur in the Arctic and Antarctic regions, there attaining a size and beauty which entitle them to rank among the most handsome of Lichens.

Genus II. PELTIGERA, *Willd.*

Gen. Char. Thallus below veined, fibrillose or spongiose, ac-

quiring a brown colour in herbarium. Apothecium suborbicular, affixed to upper surface of extremities of elongated or produced lobules of thallus, at first covered by a very thin thalline membrane or veil, which soon dehisces. (Name from *pelta*, a target, and *gero*, to carry.)

1. PELTIGERA VENOSA (*vena*, a vein). Thallus erect, small, simple, ovate, becoming sublobate or fan-shaped, dark green above,—below white, variegated with brown, thick, branching veins, which converge into a common pedicle; apothecium reddish or blackish-brown, orbicular or transversely oblong, with a thick margin.

A very elegant, small, not very common subalpine species, growing on the mud of walls, and on the earth in the chinks of rocks frequently about waterfalls, in various parts of the Highlands, as in the vicinity of Ben Lawers and Blair Atholl; and also to a less extent in the Lowlands, as in Dumfriesshire. The cells of the medullary tubes and of the cortical layer have greatly thickened walls, and are larger and coarser than in any other *Peltigera* we have examined. The spores (in a specimen from Reikie Linn, Den of Airlie, Forfarshire) are elliptic-oblong, triseptate, much broader, shorter, and more obtuse at the ends than those of any other species of *Peltigera;* they more resemble the

spores of *Solorina* or *Sticta*. Its geographical range is not wide: in Europe it is bounded by Lapland on the north and Switzerland on the south; it occurs in various parts of North America; and in the Antarctic regions only in Kerguelen's Land.

2. PELTIGERA APHTHOSA (*aphthæ*, a disease of the mouth in children). Thallus prostrate, smooth, besprinkled with darkish warts, apple-green above,—below white, reticulated with blackish veins, fibrillose or spongiose; lobes large, rounded; apothecium chestnut-coloured, vertically affixed to the produced and ascending lobules, becoming elongated, with revolute margins.

A large and handsome species, growing in moist localities among rocks and moss, and on mossy trees, chiefly in sub-alpine districts; it is not very common in Britain, but occurs in Breadalbane and other Highland districts, in the neighbourhood of the Falls of Clyde, and in similar localities. In geographical range it extends northward to the Arctic regions, where it represents *P. canina;* but does not occur in the Antarctic regions. Its name is derived from its having been boiled in milk by the Swedes, and given to their children for the disease termed *aphthæ*, or "thrush." It has been said to possess purgative, vermifuge, and

emetic properties, probably on insufficient or imaginary grounds.

3. PELTIGERA CANINA (*canis*, a dog). Thallus prostrate, membranaceous, brownish-green or greyish, subtomentose, below spongiose, whitish, reticulated with pale brownish veins, which generally give off vertical fibrils; apothecia chestnut-coloured, at first involute in the margins of the thalline lobes, affixed vertically to the produced and ascending lobules, orbicular, becoming elongated, with revolute margin. (E. B. 2299 var. *ulorrhiza*.)

A small digitate-lobate variety is called var. *spuria*; along with the commoner form it is sometimes sorediiferous.

A very common Lichen, growing in somewhat moist places among moss, on stones, the ground, or mossy tree-trunks or roots in lowland, as well as subalpine and alpine, woods and heaths. The change in colour produced by drying is very marked: in the moist state, growing among moss, it has frequently a deep apple-green colour, but herbarium specimens have usually an ashy-grey or brownish tint. Hence its familiar name is "Ash-coloured Ground Liverwort," under which designation it is to be found in the shops of some of the London herbalists. This is a good species in which to study the cells of the vegetative

system of Lichens; they are here very large and distinct. The cortical tissue, which is properly confined to the superior surface, consists of a series of large thick-walled cells, originally or typically globular, but which present great irregularity in form on account of pressure in a state of close aggregation; they frequently exhibit an irregularly hexagonal form, giving the cortical tissue the character of a honeycomb network, or they are polyhedral. The lower surface is unprotected by a distinct epidermic tissue, but is traversed by venules, which, along with the vertical processes or fixuræ, which they send off at intervals, are composed of the medullary filaments, or of filaments similar thereto. These medullary filaments are broad and branching, and are composed of a series of comparatively short, broad, somewhat cylindrical cells,—with walls greatly thickened, apparently from internal deposits,—which give them a jointed appearance. The thecæ are elongated, narrow, and eight-spored; the spores are closely packed spirally, and are fusiform and much elongated, pale yellow, quadrilocular or triseptate, sometimes curved in various degrees in the old state. The young spore is a simple fusiform cell, full of a grumous or finely granular protoplasm; this becomes separated into distinct portions, in the same manner as in

the young state of other spores we have already described; septa gradually appear, and the secondary cellules are finally and fully developed. The young spore frequently has a linear form, and is very delicate and transparent; in this state it is difficult to distinguish it from the paraphyses, which are filiform and also very delicate.—In studying the British Peltigeras, we have found little difference, save in size and the number of the septa, in the characters of the spore; and the same remark applies, to some extent, to the other cell-elements of the reproductive and vegetative systems. The spermogones,—which in the Peltigeras are frequently absent, and when present are to be looked for on the margins of the thallus,—occur as small obtuse tubercles, resembling the nascent apothecia, than which they are generally more deeply coloured; their cavity is simple, but very narrow. The sterigmata are staff-shaped, almost solid filaments, somewhat irregular, articulated and ramose at the base; they generate, in succession, from their apices, many colourless, ovoid, transparent spermatia. These spermatia differ remarkably in size and form from those of most other Lichens, and more resemble the stylospores formerly described; but there seems no good reason to doubt their being really spermatia.—This Lichen is somewhat widely distributed, occurring in Europe between Lapland and

Switzerland, over the greater part of North America, in Chili and other parts of South America, and in India; in the southern hemisphere however it occurs only on the island of Juan Fernandez, the fabled scene of Robinson Crusoe's adventures; and in the Arctic regions its place is taken by the preceding species. Its specific name is derived from its celebrity at one time in the cure of hydrophobia; it formed the basis of the "pulvis antilyssus" (*ἀντί*, against, and *λύσσα*, canine madness) of Dr. Mead, which consisted chiefly, in addition, of black pepper. It was so lauded as a sovercign cure, that it was admitted into the London Pharmacopœia in 1721; but, we may add, very properly expunged in 1788. In the History of the Royal Society it is mentioned that several rabid dogs belonging to the Duke of York were preserved by its means. In estimating the chances of its efficacy, it is interesting to consider the circumstances under which the worthy doctor prescribed it: the patient was bled and directed to take, for four consecutive mornings, in warm milk, a dose of his favourite powder; thereafter he was instructed to take a cold bath every morning for a month, and for a fortnight subsequently three times a week!*

* Sir Hans Sloane, in Phil. Trans., vol. xx.: Mortimer, in Phil. Trans.: Dr. Mead on Poisons, 5th ed., 1818.

4. PELTIGERA POLYDACTYLA (πολύς, many, and δάκτυλος, a finger) differs from *P. canina* chiefly in the smooth, shining character of the upper surface of the thallus; fertile lobules often very numerous, and somewhat digitately arranged. A variety, *scutata* (E. B. 1834), is marked by shortened fertile lobules, and small orbicular apothecia. Its habitat resembles that of *P. canina*, but it is much more rare; it occurs in various Highland districts, as the vicinity of Callander, from which we have seen specimens in fine fructification. The variety *scutata* is chiefly found on trees, and occurs in the Breadalbane Highlands, the neighbourhood of Inverary, and other parts of Scotland, though very sparingly. This species is more widely distributed in central and northern Europe and America than *P. canina* or *P. venosa*; it occurs in the Antarctic regions, and in various warm climates, as the West Indies, Colombia, and the Cape.

5. PELTIGERA HORIZONTALIS resembles the two preceding species, differing chiefly in the apothecia being transversely oblong, flat, and horizontal, with a thin, subcrenulate margin.

It also grows on moist, shady rocks, and on mossy trunks and roots of trees in subalpine and lowland regions, but is

much less common than *P. canina*. We have seen fine specimens, with very large apothecia, from Switzerland. It is spread over central and northern Europe and North America, and occurs in Kerguelen's Land in the Southern hemisphere, and in the Arctic regions.

6. PELTIGERA RUFESCENS (*rufesco*, to become red) resembles, and grows sparingly along with, *P. canina*, than which it is smaller and thicker; its lobules are somewhat narrow, with elevated and crisped margins, and its apothecia are vertically adnate, oblong, and revolute. (E. B. 2300.)

7. PELTIGERA SYLVATICA (*sylva*, a wood) differs remarkably from preceding species in the presence of urceolate, white cyphellæ on the lower surface of the thallus, which is non-fibrillose; its upper surface is covered with soot-coloured granules or granular masses; extremities of thalline lobes bifid or trifid; the apothecia are brownish-red, oblong-round, but appear only to have been found in Britain by Dr. Burgess, as mentioned in the 'English Botany' (Schærer states, "*præter Dillenium et Leersium a nemine visa*").

It grows about the mossy roots of trees and on the ground and stones, in subalpine and alpine woods. It occurs about the Falls of Clyde, Falls of Moness, Inverary, Glencoe, and other parts of the Highlands. With the older Lichenologists,

we regard this species as a *Sticta*, and quite separated from the Peltigeras by its cyphellæ. Though very rare in fructification, it sometimes possesses spermogones similar to those of *Sticta pulmonaria*; but they are very minute, and with difficulty visible.

Genus III. SOLORINA, *Ach.*

Gen. Char. Thallus coriaceous-membranaceous, veined or fibrillose below. Apothecium suborbicular, affixed to upper surface of central lobes of thallus; at first veiled by a very thin thalline membrane, which soon dehisces, forming an evanescent margin.

This genus is closely allied to *Peltigera* in the mode of evolution of the apothecium; it may be considered as a transition-form or connecting link between *Peltigera* and *Sticta*.

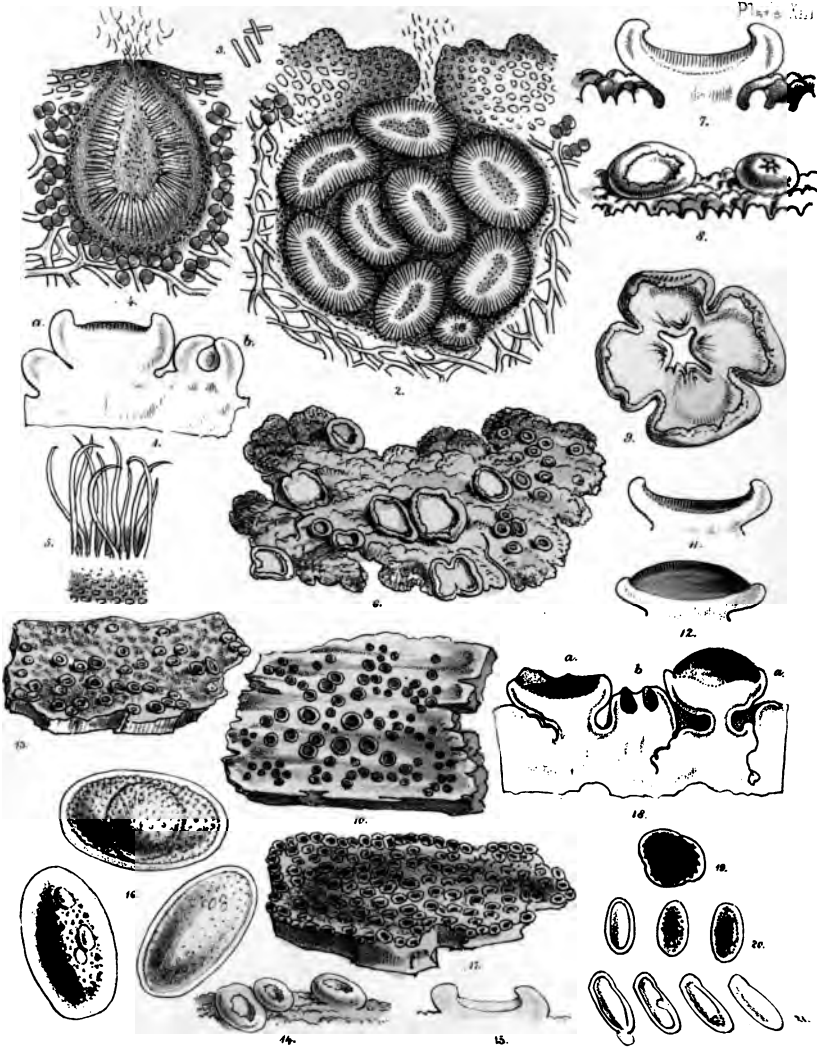
1. SOLORINA CROCEA (*crocus*, saffron). Thallus,—above dull green, becoming cinnamon-coloured when dry,—below of a rich saffron-colour, villous, reticulated with brownish thick veins,—prostrate, laciniate-lobate, with crisp margins; apothecia chestnut-coloured, flat, appressed.

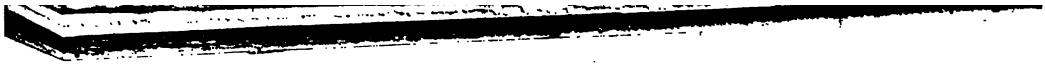
A very elegant alpine species, growing chiefly on granitoid rocks or on a micaceous soil on the summits of many of

our Highland mountains, such as Ben Lomond and Ben Lawers. As in *Peltigera*, the cells of the vegetative system are very large and distinct. The thecæ are large, elongated, and eight-spored; the spores are large, broadly ellipsoid, brownish, bilocular or uniseptate, closely packed spirally. From their size and distinctness, this is a good species in which to study the thecæ, spores, and paraphyses.

2. SOLORINA SACCATA (*saccus*, a bag or pouch). Thallus, above bright green, becoming, when dry, greenish-grey, —below white and fibrillose-gibbous; apothecia blackish-brown, at first appressed, then depressed and saccate.

A less elegant and less common species, growing on earth in the fissures of damp and shady rocks in various parts of the Highlands. The peculiar bagged or saccate character of the fructification is well seen only in old plants. Its spores are thick-walled, broadly ellipsoid or oval-oblong, bilocular, and of a deep brownish tint; they are remarkable in being externally punctate-granulose. In germinating, they send from both extremities a colourless filament,—proceeding from the endospores,—which gradually becomes elongated and very ramose.


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Nat. Ord. V. *UMBILICARIACEÆ.*

Fam. Char. Thallus foliaceous, cartilaginous, prostrate, below fibrillose or naked,—affixed by a single central point, which is umbilicated or reticulate-rugose above, monophyllous and lobate, or polyphyllous and imbricate-lobate. *Apothecium* always black; patellate, flattened, sometimes becoming convex, margined, horny, gyrose (marked by plicate or gyrate furrows), seldom simple on surface or papillate; exciple at first closed and thalline, becoming proper and carbonaceous. (Name from *umbilicus*, the navel.)

Genus I. UMBILICARIA, *Hoffm.*

A very natural and distinct, and an essentially montane or alpine family. Its fructification approximates it to the *Graphideæ*.

1. UMBILICARIA VELLEA (*vellus*, a fleece of wool). Thallus, above greyish-pruinose, becoming bronze-coloured,—below from ochroleucous becoming brownish or blackish, papillose or hirsute; apothecia sessile, appressed or depressed, at first papillate, then concentrically plicate, with a thin or thick margin.

Some varieties of this species (the *Gyrophora murina* of older authors) yield a fine orchill, and are imported to a considerable extent into the London market from the Nor-

wegian mountains, for the manufacture of orchill and cudbear, under the name of "Norway Rock Moss," or "Velvet or Velutous Moss." Spermogones are abundant on some varieties, roughening the pale surface of the thallus with their minute, conical black tubercles, which are either grouped towards its periphery or irregularly scattered; they are immersed, very dense and easily sectioned, regularly ellipsoid in figure, having a simple cavity. The sterigmata are articulated, ramose, and solid; spermatia very fine and straight. In other species the spermogones are less easily recognized by the naked eye, from the darker colour of their thallus. Like most of its co-species, it grows chiefly on granitoid rocks, on very high mountains, or in Arctic and sub-Arctic regions. On the Mexican volcano of Orizabo it occurs at a height of between 13,000 and 14,000 feet, along with other species. It is one of the Umbilicarias which constitute the "Tripe de Roche" of sub-Arctic America and the Polar regions. This black, leathery, forbidding-looking "Rock Tripe" is often boiled and eaten by the Canadian hunter when pressed by hunger; in Iceland it is frequently eaten in periods of scarcity as a supplement to the more nutritious "Iceland Moss;" and it has been repeatedly mentioned in the narrative of Polar voyages as having been the

means of saving the crews from perishing by starvation. The nutritive properties of the Umbilicarias depend on the presence of a large amount of starchy matter. When boiled they yield, like *Cetraria Islandica*, a firm, nutrient jelly, which is however accompanied, as in that Lichen, by a bitter principle possessed of purgative properties. This purgative bitter has been the source of much danger to Arctic travellers, who have been compelled to live for a time on "Tripe de Roche." In the account of Franklin's first land expedition, as detailed in Simmonds's 'Sir John Franklin and the Arctic Regions,' occur the following passages illustrative of this point:—"After feeding almost exclusively on several species of *Gyrophora* (the Umbilicarias of this Work), a Lichen known as 'Tripe de Roche,' which scarcely allayed the pangs of hunger, on the 10th they made a good meal by killing a musk-ox. . . . Mr. H—— was also reduced to a perfect shadow from the severe bowel complaint which the Tripe de Roche never failed to give him. . . . Not being able to find any Tripe de Roche, they drank an infusion of the Labrador tea-plant (*Ledum palustre*), and ate a few morsels of burnt leather for supper. This continued to be a frequent occurrence." Linnæus speaks of some Umbilicarias as superior in nutritive qualities to the Iceland Moss.

2. UMBILICARIA PUSTULATA (*pustula*, a pock or blister). Thallus greyish-pruinose, pustulate, usually besprinkled with dark greenish powdery masses, olive-coloured when moistened,—below smoothish, brownish, reticulate-lacunose; apothecia sessile, orbicular, somewhat simple, with a thick, often roughened margin.

A peculiar and distinctly-marked species, not uncommon on granitoid rocks on the tops of various Highland mountains: it is seldom found fertile, but Sir W. Hooker mentions having gathered it in fructification in Skye. It possesses a double cortical layer, the superior being thin and composed of small polygonal cellules intimately united; the inferior comparatively thick, horny, and very hygrometric, formed of globular, thick-walled cellules, so closely united that their individual boundaries are not recognizable; the free surface of the latter is marked by the presence of an infinite number of minute conical papillæ composed of the same tissue. Its thecæ are somewhat short and broadened, containing one perfect or sometimes two abortive spores; the spores are large, oval, and muriform or cellular (containing a great number of secondary cellules, arranged in parallel rows like the bricks in a wall, or irregularly). Its spermogones are rare, and occur in the form of isolated obtuse tubercles;

they are immersed, have a thin, blackish envelope, a greyish horny tissue, and are apparently devoid of a free cavity. The sterigmata are ramose and solid, closely aggregated, forming a most compact or dense tissue; the spermatia very numerous, fine, and straight. Subjected to ammoniacal maceration, this species yields a very rich orchill, and is largely imported by the London orchill-maker from Norway and Sweden under the commercial designation of "Pustulatous Moss." Linnæus speaks of it as yielding a red dye, and Withering as capable of furnishing also a black paint.

3. UMBILICARIA POLYMORPHA (πολύς, many, and μορφή, shape). Thallus greyish-pruinose or fuliginose, ciliated with rigid, ramose, black fibres, or naked,—below ochroleucous or blackish-grey, hirsute or naked; apothecium sessile or pedicellate, concentrically plicate, margin thin, at last obliterated.

There are several varieties, depending on the thallus being mono- or polyphyllous,—its surfaces smooth or roughened, and pale or dark-coloured,—its margins ciliate or naked,—and on the varying characters of the apothecia. Of these the most important and common are var. *cylindrica* (E. B. 522) in which the thallus is usually somewhat simple or smooth above, with fimbriate or fibrillose, sometimes naked,

margins; and var. *deusta*, in which the thallus is greyish-fuliginose and rugose, with naked margins. These varieties, with their sub-varieties, include the *Gyrophora cylindrica* and *proboscidea* of older authors. They are comparatively common on the granitoid rocks of the summits of many of our Highland mountains; we have met with them also at comparatively low elevations, as on a wall on the slope of a hill a few hundred feet above the mineral well at Inverleithen, Peebles-shire. The var. *deusta* usually occurs at higher elevations than var. *cylindrica*. The spermogones of this species are frequently abundant, and their presence is indicated by scattered, small, black grains resting on a slight circular elevation formed by their bodies. They are globular or ovoid, depressed or conical; their constituent elements or contents resemble those of *U. vellea*. The thecæ are eight-spored, not large, but very delicate; the spores are also delicate, oval, simple, usually colourless. Sometimes they appear double-walled, have a faint yellow shade, exhibit granular contents with a slight septate division, and have more of an ellipsoid or oval-oblong form. They are much alike in all the species and varieties which we have examined from home and foreign localities, with the exception of *U. pustulata*. Some varieties, probably

from particular localities, are said to yield violet and red dyes; others, or perhaps the same, are used, as in Iceland, to dye woollen stuffs brownish or greenish; and Linnæus speaks of the variety *deusta* as yielding a paint much used in Sweden, called "Tousch." In our own experiments on the dyeing properties of Lichens we found many of the Umbilicarias capable of yielding an orchill; but the var. *cylindrica* of this species was a remarkable exception, furnishing no purple or red tinge on ammoniacal maceration.

4. UMBILICARIA POLYPHYLLA (*φύλλον*, a leaf). Thallus bronze-coloured, below from ochroleucous becoming brownish-black, smooth, naked or very finely blackish-pulverulent. Apothecia in young state flat, margined, papillate or having few concentric plicæ; in old state immarginate, becoming convex, having many plicæ irregularly aggregated, often disposed longitudinally.

In its most common variety, *glabra*, the thallus is monophyllous or imbricate-lobate, smoothish or naked on both sides, sometimes blackish-pulverulent below; the apothecia are rarely or never met with.

A comparatively common species on the granitic rocks of the Highland mountains; occurring also on hills of minor elevation, as the Cheviots.

5. UMBILICARIA EROSA (*erodo*, to eat into, or perforate) is distinguished by the reticulate-cribrose character of the thallus, which is bronze-coloured,—below ochroleucous or brownish and papillose. Apothecia innate, then appressed, otherwise resembling those of preceding species. Spermogones frequently abundant, but not easily seen, from having the same colour as the thallus; they are small, prominent, obtuse tubercles, with an imperceptible pore or ostiole; their structure and contents resemble those of *U. vellea*.

This is somewhat rarer than the preceding species, but occurs in similar localities.

6. UMBILICARIA POLYRRHIZOS (ῥίζα, a root) is chiefly distinguished by the fibrillose-pannose character of the black under-surface of thallus, and by the apothecia being depressed, tumid, devoid of a margin, and marked by lirellæ radiating from the centre to the circumference.

Its habitat is similar to that of preceding species; it is not uncommon in the Highlands, and on the border-hills. All the Umbilicarias when moistened are of a more or less deep green or olive-green colour, becoming greyish, bronze-coloured, or blackish in the herbarium. With the marked difference in colour between the natural and dried state, every botanist is familiar who has collected these leathery

vegetations amid the moisture-laden mists which almost constantly envelope the summits of our higher Highland mountains.

Nat. Ord. VI. *PARMELIACEÆ.*

Fam. Char. Thallus foliaceous, laciniate or squamulose, prostrate or ascending,—below of different colour. *Apothecium* scutellate, normally affixed by a central point. *Thalamium* concave or flat, sometimes tumid, varying in colour.

Genus I. STICTA, *Schreb.*

Gen. Char. Thallus laciniate-lobate, expanded from a centre; below tomentose, and marked by naked *gibbi* (discoloured spots) or by *cyphellæ*. Apothecia sessile, marginal or superficial, somewhat obliquely affixed: thalamium at first closed or nucleiform, becoming elevated and explanate; colour usually similar to that of the thallus or brownish.* (Name probably from στικτός, spotted, in allusion to the gibbi and cyphellæ.)

* *Thallus below gibberose: gibbi naked.*

1. STICTA PULMONARIA (*pulmo,* the lungs). Thallus cori-

* De Notaris, "Osservazioni sul Genere Sticta" in the "Memorie della Reale Accad. delle Scienze di Torino," 2nd series, vol. xii., and in "Giorn. Bot. Ital." Ann. ii.: Delise, L'Hist. du Genre Sticta, 1822.

aceous,—above greenish or olive-coloured, deeply reticulate-lacunose, usually roughened by pale soredia,—below brownish-tomentose, with white gibbi; laciniæ broad, elongated, sinuate-lobate, extremities retuse-truncate; apothecia normally marginal, rarely superficial.

A common and handsome species, growing on the rugged bark of old forest-trees, particularly the oak, and also sometimes on damp rocks. Corticolous specimens are frequently abundantly fertile; saxicolous forms are generally dwarfed and sterile. Its thecæ are long, narrow, slender, and eight-spored; the spores are of medium size, ellipsoid, sometimes more oblong, rounded at the ends, bilocular, and pale yellow. The spermogones may be recognized as minute, depressed, brownish punctuations, scattered over the surface, and chiefly towards the periphery, of the thalline lobes. They are globular or nut-shaped, unicellular, easily enucleated from the thallus, and have a scarcely visible ostiole. The sterigmata are simple or branching, and consist of a series of cubical, rounded, short articulations. The spermatia are generated laterally from their supports, or from the upper and outer surface of the constituent cells, so numerously as to give the sterigmata a somewhat bristly appearance; they are linear, straight, squared at both ends, and very minute. In

properties it resembles *Cetraria Islandica*, containing like it starchy matter (though in very small amount), gum, bitter and astringent principles, and a brownish colouring matter; on these properties depend its economical applications. Its specific name, as well as its familiar designation, "Lungs of Oak," or "Tree Lungwort," are due either to its efficacy, real or supposed, in pulmonary affections, as a nutrient, demulcent, or tonic; or from some fancied resemblance between the reticulate-lacunose character of the thallus and the mesh-like structure of the lungs. Its alleged virtues in pulmonary affections led to its being at one time in this country frequently prescribed to invalids in the form of jellies or diet-drinks. The Swedish peasantry were wont to employ it in the epidemic catarrh of cattle, and especially of sheep; and in Germany, probably for similar purposes, it was given to cattle mixed with salt. It was also at one time much used as a tonic and astringent in a great variety of diseases. Its astringent principle has been applied to the purposes of the tanner, and its bitter to those of the brewer as a substitute for hops. A Siberian monastery once acquired a celebrity for its beer, which was flavoured with the bitter principle of this Lichen. Its colouring matter has been largely applied to the dyeing of stockings, yarn, and woollen

goods, by the peasantry in various parts of the Scotch Lowlands, where the Lichen is one of the "crottles;" in the north of Ireland, where it is called "Hazel Rag," or "Hazel Crottles;" in Herefordshire, where it is called "Rags," and in other English counties; in the Isle of Man; as well as in different parts of Germany and France. This species is one of the largest and most handsome of the British Stictas; but the genus attains its maximum development only in the Tropics, where its species possess a great size and beauty, frequently covering the trunks of huge forest-trees. Stictas are also among the most handsome of Antarctic Lichens, such as *S. endochrysa*, which has a beautiful golden-yellow thallus, and is abundant in Fuegia, Juan Fernandez, and New Zealand. It is curious, in regard to the geographical range of Lichens, to remark that the Stictas appear to be substitutes in the Antarctic regions for the Umbilicarias, which are largely developed in the Arctic regions, where Stictas are altogether absent. *S. pulmonaria* occurs on the Himalayas, and in other parts of the world, but does not appear to be widely diffused.

2. STICTA SCROBICULATA (*scrobiculus*, a little furrow). Thallus above greyish-green, deeply or slightly reticulate-lacunose, usually roughened by lead-coloured soredia,—be-

low brownish-tomentose, with white gibbi; laciniæ broad, rotundate-lobate; apothecia normally superficial, but rare.

Habitat: mossy and damp trunks of trees in subalpine woods. We have found it abundantly on the shores of Loch Lomond, and have specimens in good fructification from Inverary. It also occurs among moss on rocky ground on the Pentland and Malvern Hills, and similar localities. This species has been found on the Himalayas. Its spores are fusiform and much elongated, bilocular or uniseptate, pale yellow, resembling those of *Peltigera*, which genus this species also resembles in the structure of its vegetative system. We have found fusiform elongated spores in some New Zealand and other foreign species which we have examined. The spores of most of the British Stictas are similar in general characters to, but intermediate in size and form between, the long, narrow, almost linear, fusiform spores of *S. scrobiculata* and the broadly ellipsoid, short ones of *S. pulmonaria;* they are also intermediate in size and form between the spores of *Peltigera* and *Solorina*. In the young as well as the old state the spore-cell contains an amorphous mass of granular matter.

** *Thallus below excavated by white cyphellæ.*

3. STICTA LIMBATA (*limbus*, a border). Thallus mem-

branaceous,—above greyish or brownish, smooth, often margined by grey soredia,—below ochroleucous or greyish-tomentose; cyphellæ plano-concave; laciniæ rotundate-lobate; lobes entire or crenate; apothecia superficial. (E. B. 1104.)

A small form growing on mossy trees and rocks, in moist shady places, as about the Falls of Clyde and the shores of Loch Lomond.

4. STICTA FULIGINOSA (*fuligo*, soot) is distinguished chiefly by the fuliginose-furfuraceous character of the upper surface of the thallus, and by the apothecia having a ciliate-radiose margin, with fugacious cilia.

Not a very common species, growing among moss chiefly on moist rocks, as at the Falls of Clyde, or on trees, as about Loch Lomond: it is rarely found in fruit. In general appearance it resembles *Peltigera sylvatica*, differing from it chiefly in its rounded, rugose lobes, covered with an isidioid or furfuraceous efflorescence, and in its normally sessile, orbicular apothecia.

5. STICTA MACROPHYLLA (μακρός, large), as its name imports, is a very large-lobed form, which has been found on rocks about the Turk Cascade, on the Turk Mountain, and on Cromaghan Mountain in the vicinity of Killarney, Ireland. It sometimes attains a diameter of a foot or up-

wards. Its laciniæ are broad, elongated, sinuate-lobate, imbricate; the lobes at their extremities bifid, retuse-truncate. By some it is regarded as a doubtful native.

*** *Thallus below excavated by citron-coloured cyphellæ.*

6. STICTA CROCATA (*crocus*, saffron). Thallus membranaceous-coriaceous,—above yellowish-green, reticulate-lacunose, besprinkled with bright lemon-coloured soredia, especially towards margins,—below brownish-tomentose; cyphellæ flat; laciniæ rotundate-lobate, lobes crenate; apothecia scattered, brownish-black. (E. B. 2110.)

A rare and small but elegant species, growing among moss on trees about Inverary, and in Glenmoriston, on rocks about the Falls of Moness, Aberfeldy; and in various parts of the Perthshire Highlands, in Scotland; on basaltic rocks in some parts of Ireland; and on Dartmoor, Devonshire. It frequently grows with *Peltigera sylvatica*, but is seldom found fertile. It appears to be somewhat widely distributed over the world, being common, according to Banbury, on Table Mountain, Cape of Good Hope; and occurring also in the Falkland Islands, Tasmania, the Sandwich and West India Islands, the United States, on the Swan River, shores of the Straits of Magellan, and west coast of South America.

7. STICTA AURATA (*aurum*, gold) differs from the pre-

ceding chiefly in the upper surface of the thallus being smoothish and margined with golden-yellow soredia, the apothecia marginal, and their margin sometimes golden-yellow. (E. B. 2359.)

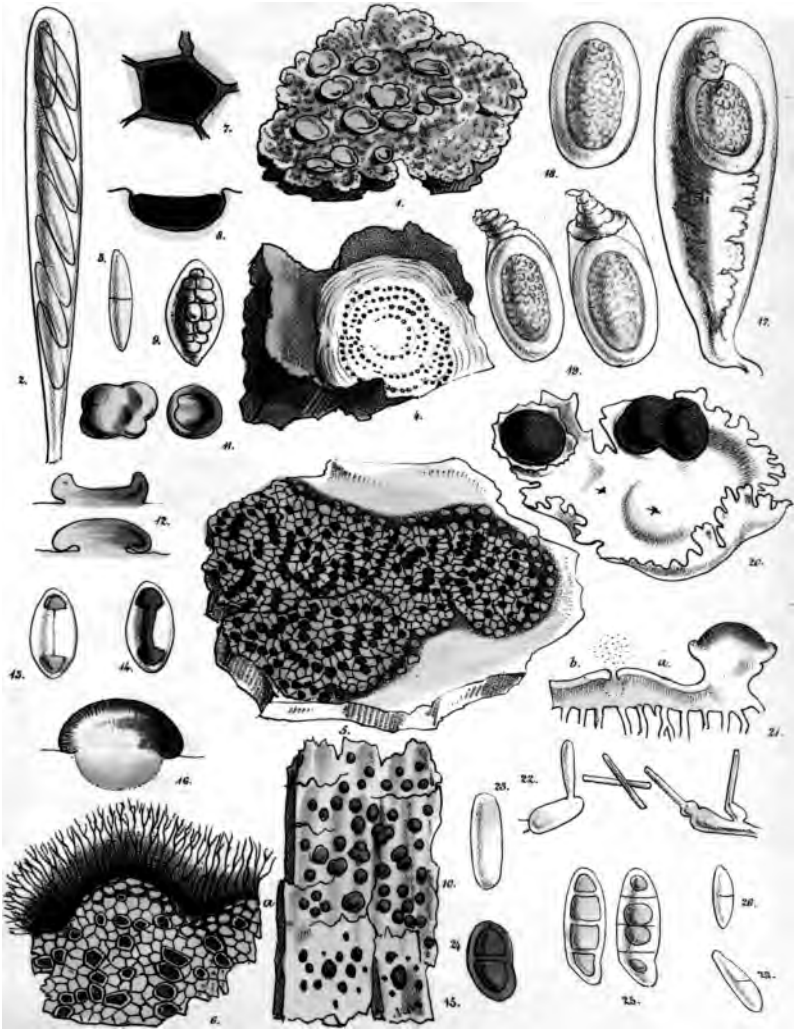
It resembles the preceding also in its habitat and in being rare in Britain. Like *S. macrophylla*, it is by some regarded as a doubtful native. We have seen it only from the New Forest, Hampshire.

Genus II. PARMELIA, *Ach.*

Gen. Char. Thallus foliaceous, prostrate, expanded horizontally from a centre; upper and lower surfaces differing in characters, latter usually subfibrillose; variously laciniate or squamulose. Apothecium scutellate, sessile, superficial, varying in colour, and differing in colour from the thallus; margins at first closed or connivent. (Name probably from *parma*, a round buckler, in allusion to the appearance of the apothecium.)

* *Thallus laciniate-lobate; lobes rounded, subascending.*

1. PARMELIA AMPLISSIMA (*amplus*, large). Thallus greyish-glaucous, membranaceous, besprinkled with blackish-green glomeruli,—below brownish-tomentose (occasionally with scattered cyphellæ); laciniæ elongated, sinuate-lobate,



Vincent Brooks Imp.

margins naked. Apothecium chestnut-coloured; margin rugose. Thallus often attains a diameter of upwards of a foot; the lobes of old plants become transversely rugose. (E. B. 293.)

One of the largest and coarsest of British species, growing on the trunks and roots of trees and on rocks in various parts of the Scotch Lowlands and Highlands, as in the Breadalbane district, about Inverary, on the Pentland Hills, and on Craigie Hill in the vicinity of Perth; but it is not very common, especially in fructification. Its spores are large, fusiform, bilocular or uniseptate, and pale lemon-yellow,—the characters of those of the genus *Sticta*. The occasional presence of cyphellæ seems also to indicate that this species more properly belongs to the genus *Sticta*, in which it was placed by Fries, under the name of *Sticta glomulifera*, a name more characteristic of its structure and affinities than the one given it by Schærer. In its young state it closely resembles a following species, *P. læte-virens*, which moreover possesses spores and spermogones having similar characters. Its spermogones are abundant and easily recognized, scattered over the thallus, external to the region occupied by the apothecia, in the form of large mammiform tubercles, whose apices are depressed and marked by a brownish

areola; in general appearance they resemble the nascent apothecia, which however have no areola and are less depressed at the apex.

2. PARMELIA PERLATA. Thallus greyish-glaucous, membranaceous, frequently sorediiferous, especially at margins,—below brownish-black, somewhat naked; laciniæ imbricate-lobate; lobes naked or ciliate at margins. Apothecium turbinate, chestnut-coloured. (E. B. 341.)

A comparatively common corticolous and saxicolous species in lowland and subalpine districts; it is rare however in fructification. Specimens in fine fruit may be seen in Tuckerman's 'Lichenes Americæ Septentrionalis exsiccati' (1847). On ammoniacal maceration it yields a fine orchill; and for the manufacture of orchill it is imported to a considerable extent into London, from the Canary Islands, under the name of "Canary Rock-moss." It occurs likewise on the Himalayas, in Ceylon, and other parts of the world.

3. PARMELIA CAPERATA (*capero*, to wrinkle). Thallus ochroleucous, membranaceous, frequently granulose-pulverulent above,—below blackish, rough, at length rugose-plicate. Apothecium chestnut-coloured; margin crenulate, pulverulent. (E.B. 654.)

Also a common corticolous and saxicolous species in low-

land regions, but rarely found fertile; on moist and shady rocks the surface of the thallus often becomes thickly granulose-pulverulent. In the north of Ireland, under the name of "Stone crottles," and also in the Isle of Man, it was used by the peasantry to yield a lemon-coloured dye for woollen fabrics. It occurs on the Himalayas, on the west coast of South America, in Van Diemen's Land, and other parts of the world. We have seen it in fine fructification from the Pentland Hills, near Edinburgh.

4. PARMELIA LÆTE-VIRENS (*vireo*, to be green). Thallus membranaceous, smooth, dull green, becoming pale-brown when dry,—below brownish-tomentose, rarely cyphellate; laciniæ sinuate-repand, rotundate-lobate. Apothecia reddish-brown; margin entire or crenulate.

Its common form, var. *herbacea*, has a simple, orbicular, broad-lobed thallus.

A not uncommon corticolous and saxicolous species in moist, shady places, in lowland and subalpine districts. Its spores are broadly fusiform or ellipsoid, rounded at the ends, bilocular or uniseptate and pale lemon-yellow. The characters of the spores as well as the occasional presence of cyphellæ justify, in our opinion, the older authors in placing this species in the genus *Sticta*, under the name

of *Sticta herbacea*. Its spermogones resemble those of *Parmelia amplissima* and *Sticta pulmonaria*.

** *Thallus sinuate-laciniate; laciniæ appressed, imbricately centrifugal.*

5. PARMELIA PLUMBEA (*plumbum*, lead). Thallus membranaceous-coriaceous, lead-coloured,—below from pale becoming bluish-pannose; laciniæ gradually dilated from centre to circumference, bi- or tripartite,—old ones zoned; margins slightly sinuate; extremities rounded, crenate; centre at length imbricate, microphylline. Apothecia red, sometimes aggregated in groups or in dark patches, margins concealed.

A corticolous species not uncommon in many parts of the Highlands, as around Arrochar, Inverary, Aberfeldy; and in some parts of the Lowlands, as Dumfries-shire. We have found it abundant on trees, especially the ash, between Tarbet and Arrochar, on Loch Lomond, and Loch Long. Its thallus is very tough and leathery, its medullary tissue very compact and almost devoid of air-lacunæ, and its gonidia have a bluish tint, as in *Peltigera*. Its spermogones occur chiefly towards the periphery of the thallus,—sometimes arranged in arcs parallel to the zones of the older thalline lobes,—in the form of isolated, somewhat indistinct tubercles with a brownish and subsequently blackish apex. Their

cavity is simple; their sterigmata small, not very ramose filaments, formed of a series of rounded cubical cellules, like those of *Sticta;* their spermatia straight and developed in large quantity from the individual articulations, that is, laterally from the sterigmata. When the spermogonal cavity becomes empty, its sterigmata increase in size, coalesce, and acquire a brownish colour.

6. PARMELIA PULVERULENTA* (*pulvis,* dust or powder). Thallus membranaceous-cartilaginous, olive-green, brownish or reddish; when dry white or greyish-pruinose,—below black-pannose; laciniæ linear-pinnatifid. Apothecium blackish-brown, greyish-pruinose, margin tumid or squamulose-foliose. There is considerable variety in the characters of the thallus; the laciniæ are sometimes very narrow, elongated and imbricate, or short, broadish, and rotundate-lobate; the thallus is sometimes non-pruinose; at other times the margin alone or the whole surface is more or less covered with a whitish efflorescence. (E. B. 2064.)

A common species, growing frequently on roadside trees, especially old ash-trees, in lowland regions, and also, but less commonly, on walls and rocks. In the neighbourhood of Perth it is abundant both on roadside trees and walls.

* The "Pulver-laf" of Scandinavia.

It often grows beside a following species, *P. stellaris*, to some varieties of which it bears a close resemblance. It would appear that these species sometimes graduate into each other not only in the characters of the thallus, but in those of the spores, which in both resemble the spores of *Physcia ciliaris*, with the exception that they are usually smaller. In *P. pulverulenta* the spores we have found to differ in size in specimens from different localities; they are sometimes as large as those of *Physcia ciliaris*, having a form like the figure of 8, being bilocular and dark-brown when mature, apple-green when younger. The protoplasmic amorphous contents of the young thecæ contain frequently a considerable quantity of oil-globules. Under a lens the spermogones may be recognized about the centre of the thallus in the form of pruinose cones, or of tubercles having a cracked and stellate apical pore; the former are isolated, the latter aggregated spermogones. Their tissue is whitish, hygrometric, and dense; their interior divided into sinuous cavities or compartments; their spermatia linear, straight, and so numerous that when mixed with a drop of water they immediately render it turbid.

7. PARMELIA STELLARIS (*stella*, a star) differs from the preceding chiefly in the thallus being naked, not pruinose,

and whitish-glaucous; below of similar colour, brownish-fibrillose. The laciniæ of the thallus vary in length and breadth, are closely arranged in a somewhat imbricate manner or are discrete, frequently elongate-fibrillose, as well as more or less deeply incised, at the margins,—flattish or arched towards their extremities, and sometimes sorediiferous. One of the most common forms resembles *Physcia ciliaris* in having a ciliated or fibrillose margin, and was at one time classed with that species in a separate genus, named after one of the most distinguished of British Lichenographers, *Borrera*. (*B. tenella* of older authors.—E. B. 1351.)

A common species, growing on roadside walls and trees. Its spores are usually somewhat smaller than those of *P. pulverulenta;* they are also more oval, often slightly curved and tapering at the extremities, though, being notched or constricted at the centre, they also resemble the figure 8. Their outer wall or epispore is thick; the endospores are large and spherical, and occupy the two compartments into which the spore is divided by its central septum. The latter, in the process of germination, generate the germ-filaments, which burst through the epispore, but are otherwise unconnected therewith. Its spermogones are scattered, small, black, obtuse tubercles; their cavity is pluricellular

and their spermatia straight. This species is found in the Antarctic regions, in North America, Australia, and other foreign countries.

8. PARMELIA CERATOPHYLLA (*κέρας*, a horn). Thallus membranaceous, whitish-glaucous, below pitch-coloured, smooth; laciniæ sinuate-multifid, somewhat convex or rounded; at their extremities inflated, imperforate, fringed or tipped with pale soredia. Apothecia reddish-brown, sometimes subpedicellate and cup-shaped, becoming explanate, margin entire. This species varies greatly in the discreteness, size, and mode of division of the laciniæ, and in the ascending or inflexed, inflated and sorediiferous characters of their extremities; the laciniæ are frequently, especially towards their extremities, black-punctate, or as if pricked over with a thick series of black points, to such an extent that one variety is denominated *multipuncta*.

One of our commonest British Lichens, growing abundantly on trees, rocks, and walls, almost everywhere. In the vicinity of Perth it is exceedingly common on the branches and stems of the fir, and on heather and other shrubs in the hill-woods; on boulders, especially granitoid, which are plentifully scattered over the face of the country; and on every roadside wall. It is also frequent in High-

land districts, and on hills of minor elevation, as the Pentlands. We have only met with it occasionally in fructification, however, in the woods on Kinnoull Hill,—so rare is it in the fertile state. Its most frequent variety (var. *physodes*) is the *Parmelia physodes* of older authors. Its spermogones are the black points formerly mentioned as frequently studding the surface of the laciniæ; they are spherical, unicellular, and have a dense, tough envelope. The spermatia are linear and straight. This species is the "dark crottle" of the Scottish peasantry, by whom it has been used to dye woollen stuffs brown. It is one of the Lichens capable of yielding a gum similar to gum-arabic, and it has been recommended by some authors as an edible species. It occurs likewise on the Himalayas and in various foreign countries.

9. PARMELIA SAXATILIS (*saxum*, a stone or rock). Thallus whitish-glaucous or bronze-coloured, membranaceous, reticulate-lacunose, frequently sorediiferous or furfuraceous, below black-fibrillose; laciniæ sinuate-lacinulate, sometimes blackish-ciliate; lacinulæ divaricate-angulose; extremities retuse. Apothecium chestnut-coloured, margin sometimes at length crenate. The "Sten-laf" of Sweden and Norway.

A very common Lichen, growing not only, as its name

implies, on rocks and stones, but also on trees, in lowland, subalpine, and alpine districts. Like the preceding, however, it is rare in fructification; in this neighbourhood we have met with it fertile on trees near Pitkaithly Wells, and on granitoid rocks and boulders on Birnam Hill, Dunkeld. It appears to be more frequently fertile in highland than lowland districts; we have found it abundantly so on Ben Lomond and the neighbouring mountains. In its most common form, in lowland districts, the laciniæ are broadish, deeply reticulate-lacunose, with somewhat naked margins, smooth or covered with a pulverulent, furfuraceous or isidioid efflorescence. A saxicolous variety (var. *omphalodes*), peculiar to subalpine and alpine districts, has a smoothish, shining, bronze-coloured thallus, with broadish, slightly reticulate-lacunose laciniæ, having sometimes black-ciliate margins: this is the *Parmelia omphalodes* of older authors; it is common on boulders and rocks on all our Highland mountains. We have found these varieties passing insensibly into each other, especially in respect to colour. The latter variety is probably more frequently fertile; its apothecia are larger, more irregular in form, sometimes confluent, and usually have a crenate margin; its spores, in the specimens we have examined, are oval or ellipsoid, simple, of medium size, pale-yellow and double-walled.

P. saxatilis has a wide geographical range, occurring in Spitzbergen and other Arctic islands; in Cockburn's Island, Graham's Land, and other parts of the Antarctic regions; on the Mexican Andes, and many districts of temperate and Arctic North America; in Brazil, Chili, and other parts of South America; in the Mauritius, and similar warm islands and countries. In northern and mid-Europe it is very abundant. It has been for ages used by the peasantry of Scandinavia, Scotland, and other countries of northern Europe, to yield a brownish or brownish-red dye for thread, yarn, stockings, nightcaps, and similar goods of home manufacture. In Scotland it is one of the most familiar "crottles," and is also known under the name of "Stane-raw," or "Staney-rag." Not only do the peasantry use it in the way we have mentioned, but it would appear, upon the evidence of the Border ballads, that the Border fairies were sometimes habited in tunics dyed with this Lichen. "Like the feld-elfin of the Saxons, the usual dress of the fairies is green; though on the moors they have been sometimes observed in heath-brown, or in weeds dyed with Stone-raw or Lichen." (Minstrelsy of the Scottish Borders, vol. ii. p. 310.) In Shetland this Lichen, in common with the dye prepared from it, is called "Scrottyie;" it is there found common on argilla-

ceous, but rarely on magnesian, rocks, and is always collected in August or autumn, because at this period richest in colouring matter. The Norwegian and Swedish peasantry use it to dye their home-made garments, sometimes adding *Parmelia parietina*, or alder-bark. In Scandinavia it appears always to have been reckoned most honourable for the inhabitants to weave their own cloths,—to make and dye their own vestments. The primitive customs of our own ancestors in this respect have been almost completely dissipated by the introduction of steam, and the progress, hand in hand, of science and art. This Lichen was once used in medicine as an astringent; by the ancients it appears to have enjoyed a celebrity as a sovereign remedy for epilepsy and the plague; and even Hippocrates is said to have prescribed it in the diseases of women.

The variety *omphalodes* yields readily to boiling water a deep brown, and, on ammoniacal maceration, a reddish-brown colouring matter, which has also been much used by the peasantry of various countries of northern Europe in the dyeing of woollen fabrics. It is the "Alaforel-laf" of the Swedish and Norwegian peasant, the "black crottle" of the Scotch Highlander, and the "kenkerig" of the Welsh mountaineer. In Ireland it was prepared for use as a dye by

steeping the Lichen in stale urine, adding a little salt, and subsequently giving the mass consistency and a ball-form by mixing with lime. Pennant affirms that it formed an important article of commerce in Scotland in 1772, selling at 1*s.* to 1*s.* 4*d.* per stone; and Dr. Walker lauds its *red* dye as of peculiar permanence, uninjured by exposure, and unaffected by acids, alkalis, or alcohol,—"a most singular property," as he truly observes (were it true), "as there is no red dye in use that remains unaltered by these powerful agents." These statements are unquestionably either exaggerated or unfounded.

10. PARMELIA CONSPERSA (*conspergo*, to besprinkle). Thallus membranaceous-cartilaginous, greenish-yellow or straw-coloured, polished, frequently black-punctate or sorediiferous,—below brownish and black-fibrillose; primary laciniæ sinuate-rotundate-lobate, secondary linear-lacinulate (developed frequently from or upon the primary). Apothecia chestnut-coloured, frequently confluent or crowded, sometimes abortive. (E. B. 2097.)

A comparatively common species, growing on walls and rocks, especially quartzose, in lowland and highland districts; it is frequently abundantly fertile. Nowhere have we found it so plentiful, and its fructification in such perfection, as

growing on old walls about Moffatt, Dumfries-shire. Its thallus frequently becomes the seat of a sorediiferous, furfuraceous, or isidioid efflorescence; in such states we have found it on Kinnoull Hill and elsewhere round Perth. Its spermogones are the black points scattered frequently over the thallus; they are globular, very minute, with a simple cavity; the spermatia are straight and very numerous.

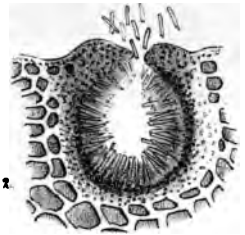
11. PARMELIA OLIVACEA (*oliva*, the olive). Thallus membranaceous, deep olive-brown, smooth, rugulose, sometimes furfuraceous or granulate-farinose—below paler or blackish, roughened, smooth at circumference; laciniæ plicate, rotundate-lobate; lobes appressed. Apothecia of similar colour to thallus, or chestnut-coloured; margin inflexed, at length rugose or crenate. (E. B. 2180.)

A common corticolous and saxicolous species on roadsides and the outskirts of woods in lowland districts. On trees, such as the oak and ash, it is usually fertile; on stones and rocks it is generally degenerate and sterile. Its thecæ are short, small, ovoid, and eight-spored; the spores small, roundish, colourless, double-walled, resembling those of *Cornicularia*; the paraphyses are very delicate.

12. PARMELIA FAHLUNENSIS (*Fahlun*, a Swedish mining village). Thallus subcartilaginous, smoothish, bronze or



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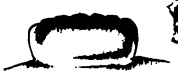
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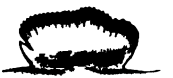
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W.L.Lindsay del. Ptoh lith.

Vincent Brooks Imp.



pitch-coloured, from membranaceous-lacinulate passing into a terete-corniculate or a capillary condition; apothecium of somewhat similar colour to thallus.

The common variety is sinuate-lacinulate: the lacinulæ somewhat concave or flattish, broadish or linear, sometimes granulose at margins, and imbricated.* (E. B. 653.) There are three other well-marked varieties: var. *stygia*,† in which the lacinulæ are palmately multifid, sublinear, convex, recurved at apices, sometimes granulose or verrucose (E. B. 2048); var. *tristis*, in which the thallus is somewhat fruticulose, horny-cartilaginous, rigid, the lacinulæ fastigiate, terete-compressed, dichotomously ramose, with naked or granulose margins; apothecia terminal, plano-convex; and var. *lanata*, in which the lacinulæ are setaceous-filiform, terete, intricate, often twisted, dichotomously ramose (E. B. 846). The two latter varieties were placed by the older Lichenologists in the genus *Cornicularia*, a classification which appears justified by the nature of their spores, which resemble those of *Cornicularia* and *Usnea*. Those of var. *tristis* are oblong or oval-oblong, small, colourless, double-walled; those of var. *lanata* are ellipsoid, but otherwise similar. All these

* The "Fahln-laf" of Sweden and Norway.

† The "Blackalls-laf" of Sweden and Norway.

varieties are in their habitat montane or alpine, growing on rocks, chiefly quartzose or granitoid, on many of our Highland mountains, such as Ben Nevis and Loch-na-gar: from the latter locality we have seen specimens of the common variety and var. *stygia* in fine fructification. On tearing across the lacinulæ of any of the forms, it will be seen that the medullary tissue is quite white, and that the very dark colouring matter is confined to the cortical layer. In var. *tristis* the spermogones may be observed roughening the lacinulæ, as in *Ramalina scopulorum*, with their rounded tubercles; they are globular, and open by an ostiole. The spermatia are linear and straight. This species has been said to yield a brownish or reddish colouring matter; if so, it must, at least, be of questionable utility.

13. PARMELIA AQUILA (*aquilus*, sun-burnt or swarthy). Thallus chestnut-coloured, membranaceous-cartilaginous, sometimes greyish-pruinose,—below paler, black-fibrillose; segments sinuate-lacinulate, imbricate, convex at centre, explanate at periphery. Apothecia brownish-black; margin entire, thick. The thallus sometimes becomes crustaceous and uniform, or subradiose at periphery. (E. B. 982.)

A common species on rocks on or near sea-coasts; it is frequent on the Pentlands, Arthur's Seat, and at Caro-

line Park, near Edinburgh; and on various hills around Perth.

14. PARMELIA PARIETINA (*paries*, a wall). Thallus yellow or orange-coloured, membranaceous,—below white, obsoletely fibrillose; laciniæ flat or lobate, disposed orbicularly, or microphylline-squamulose. Apothecium of similar colour to the thallus; margin elevated, very entire.

A most protean Lichen, and at the same time one of the commonest species, growing on trees, palings, rocks, and stones, almost everywhere, in lowland districts; it is abundant, and in fine fructification, on roadside walls and hedges,—hence probably its Scandinavian name, "Waglaf." There are a great many varieties, depending primarily on the characters of the laciniæ, and secondarily on the colour of the thallus and the characters of the apothecia. The thallus may be macro- or microphylline; the laciniæ may be broadish and rounded, linear and truncate, simple or lacerate-dissected, concave, flattened or ascending towards periphery, naked or granulose, imbricate or complicate in their arrangement. The thallus may have more or less of a reddish or gamboge-yellow tinge; in moist shady situations it is generally greenish or bluish. Its surface is frequently granulose or pulverulent, and it sometimes degenerates into

a leprose, amorphous mass of the character which we have already described as that of the old genus *Lepraria* (var. *viridis*, E. B. 2148). The apothecia have sometimes more or less of a red tint, their margin disappears, they become irregular in form, and often confluent or closely crowded (E. B. 1795); at other times they are of very minute size, though very numerous. One variety, *Candelaria*,—so called from being used by the Swedes to dye the candles set apart for their religious ceremonies,—has lately been transposed by Massolongo into a separate genus (*Candelaria vulgaris*). It is microphylline, lacerate-dissected, and the margin of the apothecia granulose-pulverulent. On moist and shady parts of walls, frequently covered or intermixed with cobwebs and dust, we have noticed a white-variegated condition of the thallus; this will be found on inspection to be due to the partial destruction, probably by insects, of the cortical layer and of the surface of the apothecia, thereby exposing the subjacent white, cottony, medullary layer. There is a double cortical layer,—the superior yellow, and consisting of thick-walled cellules closely aggregated; the inferior white, composed of similar cell-elements, more hygrometric, and giving off numerous filamentous fixuræ from its under-surface. The paraphyses are linear, claviform, com-

posed of five or six oblong cellules in apposition by their extremities, simple, rarely furcate. The thecæ in the young state are somewhat linear or narrow, but when full of mature spores are broadly obovate, presenting irregular bulgings corresponding to the individual spores. The thecæ and paraphyses, with the exception of the terminal cell, along with the hypothecial tissue, are coloured blue by iodine. The spores are somewhat small, oval, colourless, simple, almost solid, excavated at their ends into two globular cavities full of yellowish protoplasm; these nuclear masses are frequently united by a narrow line of the same material running in the long axes of the spores. The thickened wall appears to consist of cellulose, and to be caused by a deposit on the interior of the epispore; it is not coloured by iodine alone, but, if sulphuric acid be subsequently added, a light blue colour is developed. The terminal nuclei were erroneously described by Schleiden as terminal caps, the remnants of a hardened mucilaginous coating of the exterior of the spore. They are the most prominent features of the spore, and are frequently distinct when the spore-wall is scarcely visible. Hence a theca full of nearly ripe spores often appears as if studded over with a series of small yellow buttons. In germinating the germ-filaments proceed from one or both

ends of the spore,—from the endospores or membrane of the cavities which contain the nuclear masses; they are usually dilated at their origin, but almost immediately bifurcate, elongate, and ramify. In proportion as this filament grows the protoplasm of the spore decreases, while its cavity increases, the deposits of the epispore gradually disappearing, like the albumen of a cotyledon, for the nourishment of the young germ. Other spores having a small supply of protoplasm also possess a thick epispore, whose thickened deposits are absorbed in proportion to the growth of the germ-filament; while on the other hand it frequently happens that spores rich in protoplasm have very thin walls, as in *Lecanora pallescens*, var. *parella*. The spermogones of *P. parietina* are small tubercles scattered or grouped towards the periphery of the thallus; their sterigmata are short, ramose, very irregular filaments, composed of delicate cubical cellules, which afterwards become nearly solid from thickening deposit on the interior of their walls. The spermatia are small and straight, and mixed with an abundant mucilage; they are developed laterally from the sterigmata, or from the upper and outer surface of their constituent cellules.

Chemical analysis has detected in this Lichen yellow and red colouring matters,—the former being *parietinic* or *chry-*

sophanic acid, which is one of the colouring matters of officinal rhubarb; several alimentary principles, as gliadine, starch, sugar, gum; several medicinal substances, as resin, bitter matter, gallic acid, and a peculiar ethereal oil; besides wax, stearine, chlorophyll, and some salts, as carbonate of lime. In young plants we have met with bundles of acicular crystals, resembling the rhaphidian bundles of many phanerogamic plants, which consist generally of phosphate or carbonate of lime. Its yellow colouring matter has been abundantly employed by the peasantry in various countries of northern Europe for dyeing woollen goods. The late Dr. Johnston of Berwick, in his interesting 'Botany of the Eastern Borders,' mentions that about Wooler children collect it at Easter, for dyeing their Pasque eggs. So lately as 1815 it was commended as a substitute for quinine and cinchona bark in intermittent fevers; and it has in many other diseases been employed as an astringent and febrifuge.* This Lichen occurs sparingly in the Arctic regions, and is found in South America and other foreign countries. Under the name of "Common yellow Wall-moss," it is to be met

* Sander: Die Wandflechte ein Arzneymittel welches die Peruv. Rinde nicht nur entbehrlich macht, sondern die auch an gleichart Heilknüften übertrifft. 4to, Sonderhausen, 1815.

with in the shops of the London herbalists, being probably kept chiefly for the purposes of the bird-stuffer.*

11. PARMELIA ELEGANS *elegans*, handsome). Thallus vermilion or orange-red, membranaceous-cartilaginous, smooth on both sides, white below, sometimes granulose above, stellate or radiose: lacinæ narrow, linear, laciniate, somewhat incrassate, convex. Apothecium of similar colour to thallus. E. B. 2151, var. *privaticaria*.)

Not uncommon on rocks and stones in lowland as well as subalpine or alpine districts. It occurs on the granitoid rocks of the summits of some of the highest mountains. On Ortabo, it was found at an elevation of 14,550 feet; by Agassiz it was seen on the summit of the Jungfrau; and on other lofty mountains it constitutes the last form of vegetation, attaining a greater height sometimes than even *Lecidea geographica*. It occurs also in the Arctic regions. It sometimes resembles, on superficial examination, small and reddish varieties of the preceding species.

**** Thallus squamulose; squamules imbricate-lobate.*

16. PARMELIA HYPNORUM. Thallus dull-greenish, be-

* For references to the chemistry of *P. parietina* see Rochleder and Heldt, Annalen der Chem. und Pharm., 1843: Herberger, Buchner's Repertorium, 1834: Schlossberger, Pharm. Journal, 1848.

coming brown when dry,—below white; squamules lobate-crenate, free at periphery; often becoming granulose. Apothecia large, reddish-brown; margin thick, at length granulose.

Not uncommon in various parts of the Highlands, growing on moss and heather, and also on the ground.

We are indebted to the kindness of Sir W. C. Trevelyan for specimens of a curious erratic *Parmelia*, recently found by him in Dorsetshire, lying loose on the ground, and rolling freely along before the wind.* It occurs in the form of irregular gnarled ball- or cake-shaped masses, of a light grey colour, and of somewhat firm consistence, each weighing from eight or ten to thirty or forty grains, and being about one inch in diameter, or having a length of three-quarters to one and a half inch, and a breadth of three-quarters to one inch. In general appearance these masses resemble the drawings of *Lecanora esculenta* and *affinis*—similar erratic Lichens found in different parts of Asia—as given in Lindley's 'Vegetable Kingdom.'† When sectioned, they are found to be somewhat solid, and appear to consist of a con-

* Its discovery will be found noted in the 'Gardeners' Chronicle,' Feb. 9, 1856, and 'Scottish Gardener,' No. 3, p. 100.

† Third edition, 1853, p. 50 c.

glomerate thallus, or to be formed of a series of superimposed, but confused, layers of thalline tissue. Many of the specimens are irregularly fissured on the surface, the fissures apparently passing into an obsolete central cavity, which has probably been the base of attachment of the plant to the twigs of trees. This attachment has probably been very loose; the Lichen has been detached by the wind, and from rolling along the surface of the ground, from a peculiar curling in or involution of the foliaceous thallus, as well as from repeated growths of secondary thalli upon the parent thallus, the present form has been apparently produced. It is contrary to all analogy to suppose that this Lichen has been free or non-adherent from birth; at the same time it is evident that it has grown and increased in size subsequent to the period of its detachment from its base of support. While this is a rare instance of a plant growing vigorously after all connection with its base of support has been severed, it illustrates, in a most conclusive manner, the fact that the nutrition of Lichens is often wholly independent of soil, and it also exhibits the influence of epithalline growths, of the multiplication of secondary thalli, in modifying the form of Lichens. It would appear however that we are not rigidly bound down to the necessity of believing that this Lichen

must, at some period of its life, have been fixed to, or developed from some base of support; for we shall afterwards see that Pallas, and Eversmann, and other Asiatic travellers assert that the manna Lecanoras of the neighbourhood of Lake Aral are free *ab initio*, and never contract any attachments or adhesions. The testimony of travellers, in regard to the occurrence of erratic Lichens having a free or non-adherent thallus, has hitherto been received with considerable suspicion; it is now however corroborated by the existence of this erratic *Parmelia* in Britain.

We have seen only barren specimens; and, in the absence of the fructification, the species to which the plant belongs cannot be accurately determined. Its characters approximate it most closely to *P. pulchella*, var. *cæsia*. The thallus is whitish-glaucous, smooth, shining, occasionally exhibiting a few scattered, punctiform, white soredia, cartilaginous-membranaceous,—below brownish, with brown fibres; laciniæ vary in size and mode of division, are very convex, much curled and twisted at margins, many of them broadened and rounded at their apices.

The genus *Parmelia* includes some of the largest and most handsome both of foreign and native Lichens. The Parmelias have been popularly denominated the "Leaf

Lichens" or "Shield-edge Lichens," in allusion to the appearance or resemblances of their thallus or apothecia.

Nat. Ord. VII. *LECANOREACEÆ.*

Fam. Char. Thallus crustaceous, effigurate or uniform. *Apothecium* scutellate, sessile, superficial: *thalamium* concave or flattish, frequently becoming tumid, varying in colour.

Genus I. LECANORA, *Ach.*

Gen. Char. Thalamium always naked, normally immarginate, flat or tumid. (Name from λεκάνη, a dish or platter, in allusion to the form of the apothecium.)

* *Thallus squamulose; central squamules crowded into an areolate crust.*

1. LECANORA CRASSA (*crassus*, thick or fertile). Thallus greenish-grey, usually white-pruinose,—below black, white at circumference; peripheral squamules subradiose-plicate, incised-lobate, rounded and crenate. Apothecium appressed, brick-coloured; margin tumid, at length evanescent. (E. B. 1893, var. *cæspitosa.*)

There are several varieties, depending on the form and arrangement of the central and peripheral squamules, the

pruinose or non-pruinose nature of their surface or margins, and their varying colour. Not uncommon on rocks and boulders, especially if thinly covered with earth, in lowland regions, as on Arthur's Seat, and roadsides round Edinburgh; some forms occur in rock-fissures on Highland mountains. The spermogones may be detected under the lens scattered here and there on the older squamules, either in the form of minute, pale-brown tubercles, entire or cracked, or of minute excavations with irregular margins; they are immersed, globular or irregular, and their cavity is divided into many anfractuosities. The spermatia are linear, strongly curved into an arc.

** *Thallus at circumference stellate-radiose, in centre rimose-areolate.*

2. LECANORA MURORUM (*murus*, a wall). Thallus yellow or vermilion-coloured, sometimes white-pruinose; peripheral laciniæ narrow incised-lobate, convex; centre of thallus areolate-verrucose, often granulate-pulverulent. Apothecium orange-coloured,—margin paler.

Comparatively common in many lowland and subalpine localities, on walls, rocks, stones, bricks, tiles, and mortar; some forms are montane or alpine. It frequently bears some resemblance, on superficial examination, to forms of

Parmelia parietina, P. elegans, and *Lecidea aurantiaca.* The *L. murorum* of E. B. (2157) is Schærer's *L. callopisma,* which has broadish and flat peripheral laciniæ.

**** Thallus uniform.*

a. *Apothecia black or brown.*

3. LECANORA ATRA (*ater,* black). Thallus glaucous or whitish, cartilaginous, usually becoming granulose-verrucose: hypothallus black. Apothecium very black (at all stages of its development), naked, frequently tumid; margin entire or crenulate. The thallus or apothecia sometimes sorediiferous or variolarioid: the latter vary greatly in size and number (E. B. 940, var. *vulgaris*).

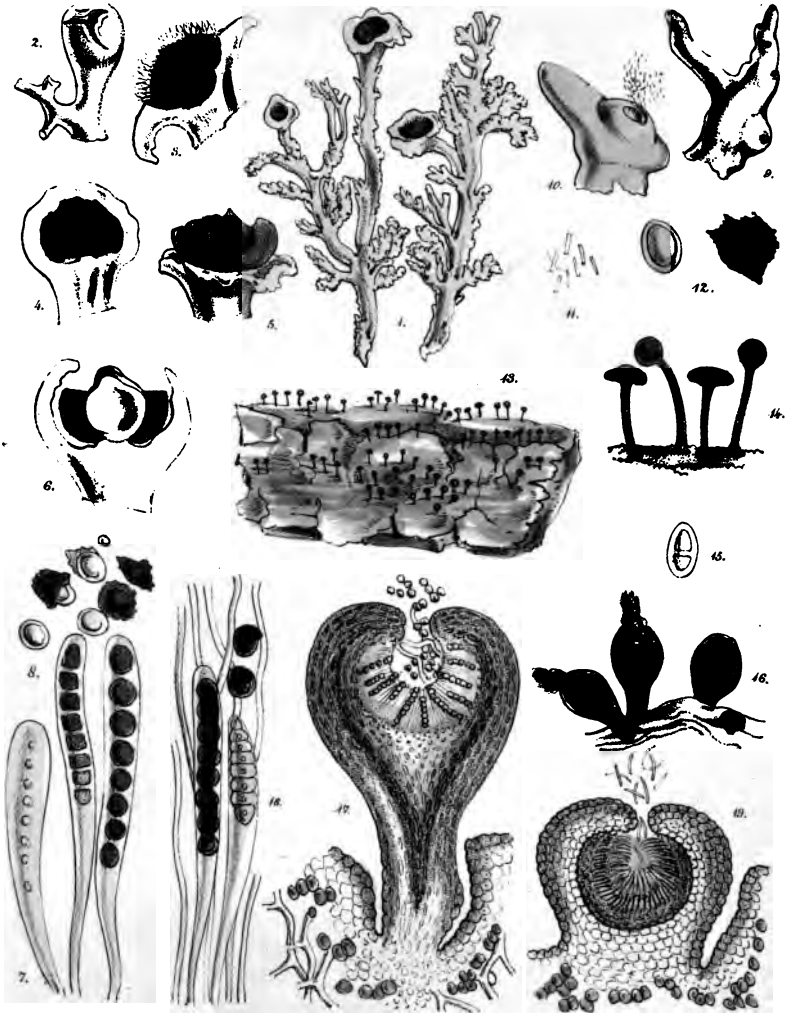
A very common species, growing on trees, rocks, and walls in lowland and subalpine regions. In the neighbourhood of Perth it is abundant on old roadside-walls. Corticolous forms frequently resemble a following species, *L. subfusca,* whose apothecia frequently become black; but they are distinguished therefrom by their apothecia being very black *ab initio.* Its spores are oval, of medium size, colourless, double-walled; they vary in size in specimens from different habitats. The young spores frequently contain a central globular cellule, surrounded by coarse granular matter; these disappear as the spores arrive at maturity, their con-

tents becoming homogeneous. Its spermogones occur in the form of minute black tubercles, round which the cortical tissue appears raised or torn; on section of the white medullary tissue they appear as greyish spots. The spermatia are very numerous, straight, and of extreme tenuity, resembling masses of needles.

4. LECANORA SUBFUSCA (*sub*, somewhat, *fuscus*, brown). Thallus whitish, somewhat cartilaginous, smoothish or granulate-verrucose; hypothallus white. Apothecium brownish, frequently becoming blackish, sometimes greyish-pruinose. There are many varieties, or corticolous, saxicolous, and muscicolous forms, depending on the varying characters both of the thallus and apothecia. The thallus is sometimes rimulose-areolate, papillose or contiguous, and of a yellowish or greenish colour; it may be sorediiferous, or may degenerate into a pulverulent crust, becoming one of the Leprarias of old writers. The apothecia may be crowded or scattered, large or small, of various shades of brown and black, concave, flattened or tumid, naked or pruinose, with a thin or tumid, entire or flexuose, crenulate margin: or they may become abortive and sorediiferous (E. B. 450, var. *leucopis*).

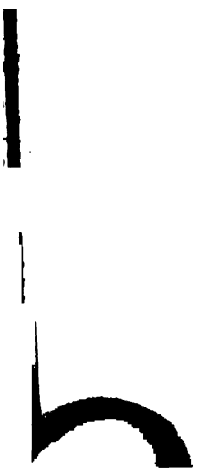
One of the commonest Lichens, growing on trees, dead wood, palings, rocks and stones in lowland regions, almost

everywhere; it is abundant in woods and on roadside trees and walls. Some varieties are peculiar to certain trees or rocks; for instance, var. *pinastri*, a non-granulose, leprose, yellowish or greenish form, grows on the bark of the *Pinus sylvestris*, the "Scotch fir:" and var. *crenulata*, which has small, flattened, subpruinose apothecia, with a tumid crenulate margin, grows chiefly on calcareous stones. A curious form, having a papillose-ramulose thallus, covers in patches decayed heather or moss in some parts of the Highlands: this was one of the Isidiums of old writers (*Isidium oculatum*, E. B. 1833), a genus which is now found to consist chiefly of isidioid, sterile and abortive forms of various species of *Lecanora*,—as *L. pallescens*, *L. rimosa*, and *L. subfusca*. In some young thalli we have observed, under the microscope, abundance of octahedral crystals, probably of oxalate of lime; but as in the case of acicular crystals in the young thallus of *Parmelia parietina*, we have not been able to satisfy ourselves that these do not really belong to the bark on which the Lichens grow. The spores of *L. subfusca* are small, oval or ellipsoid, colourless, simple or double-walled, and are in the mature state full of homogeneous oil. They germinate in the same way as those of *Parmelia parietina*. The spermogones may be observed



W.J. Lindsay del. Etch. Lith.

Thwaites Brothers Imp.



under the lens as small black points seated on the verrucosities of the thallus, or lodged in the sinuses or chinks which separate these. They are globular or ellipsoid, at first pale, but becoming brownish and sometimes almost black; they have no free cavity. The sterigmata are straight, very slender and crowded: the spermatia acrogenous, linear and curved. This and the preceding species have a wide geographical range, occurring in the Antarctic regions, in South America, and other foreign countries.

b. *Apothecia whitish or flesh-coloured.*

5. LECANORA PALLESCENS (*pallesco*, to grow pale). Thallus whitish or greyish, membranaceous-subcartilaginous, tuberculose-rugose. Apothecium pale flesh-coloured, white-pruinose; margin tumid. The thallus is frequently isidioid, especially when saxicolous; on stones also it is often tartareous, white, friable, and mealy: it may be somewhat membranaceous, especially on trees, and rimose or areolate-verrucose. The apothecium is sometimes concave, flattened or tumid with a thinnish or tumid, inflexed or rugose, margin; it may become abortive and variolarioid.

A common species, growing on trees, rocks, and stones in lowland, subalpine, and alpine regions; it is abundant on roadside walls. Its most common variety, var. *parella*, a

rimose, areolate-verrucose form, which is both saxicolous and corticolous in its habitat, with a rugose, white-pruinose apothecium, is the *Lecanora parella* of older authors (E. B. 727). Its specific name is said to be derived from its having been for ages known in France as the "Perelle d'Auvergne," on account of its yielding, on ammoniacal maceration, a fine orchill, called the "Orseille d'Auvergne." This pigment was prepared chiefly at St. Flour and Limoges, and the Lichen was collected by the peasantry of Auvergne, Limousin, Languedoc, Provence, Lyons, and other districts of southern France. Manufacturers distinguished two varieties, white and grey, depending chiefly on the maturity and purity of the plant, the latter being preferred. The operation of maceration or preparation extended over ten or twelve days, and consisted essentially in the steeping of the Lichen, ground into a pulp, in stale urine,—the addition of lime, and sometimes alkalies,—and the moulding of the mass into parallelopipeds or small cakes, like those of litmus. Under the name of "Light Crottle" it has been much used by the Scotch Highlanders to yield an orange or reddish dye for woollen goods; and, as the common "Crab's-eye Lichen," it appears to have been gathered in the north of England, according to Withering, for the London orchill-maker. We

have found various saxicolous varieties of *L. pallescens*, especially isidioid, variolarioid, or tartareous forms, from different habitats,—maritime, lowland, and alpine,—to yield good qualities of orchill; corticolous varieties are usually too thin and scarce to be so employed. Under the name of "White Crottle," isidioid saxicolous forms have been used by the peasantry of this and other countries, in the preparation of a red or crimson dye. As a general rule, the isidioid or coralloid form of all crustaceous Lichens may be set down as colorific. The spores of var. *parella* are large, oval, double-walled, the epispore being delicate, transparent, and colourless; the endospore, on the contrary, thick, and its contents granular and oily, sometimes having a faint yellow tinge. The two coats are usually more or less closely united, requiring the use of reagents to dissociate and render them distinct. After the escape of its contents, the spore appears as a large pellucid or hyaline vesicle, frequently corrugated or plicate. In the young state the endospore frequently contains a large central, globular cell, surrounded by granular matter, mixed with a considerable amount of oil-globules. The germination of these spores is peculiar. When first discharged from the theca their outer coat is transparent, but it soon becomes opaline, a change probably due to disaggregation of

its two layers. Gradually, from all points of their surface, whitish filaments are developed, radiating in every direction; they ramify towards their extremities, and by the interlacing of their ramifications, form a hypothallus. These filaments are almost solid, and proceed from the epispore alone, which, along with its bristly coating, may easily be rubbed from the endospore by gentle friction between glass. As the filaments become developed, the granular and oily contents of the spore are converted into an emulsion, and then gradually disappear. The spore itself meanwhile undergoes no appreciable change, but it probably serves as the nucleus of the first cellular layers of the future thallus. The spermogones of this variety are difficult of discovery, from their opening on the surface of the thallus by an almost invisible pore; they are to be looked for by repeated sections of the white medullary tissue, in which they appear as yellowish spots. They are ovoid and pluricellular (divided into sinuous cavities or compartments); their sterigmata are linear and simple, or slightly ramose; their spermatia acrogenous.

The variety *Upsaliensis*, which has a membranaceous-verruculose thallus, is a peculiar form growing on decayed grass, moss, or heather, on various Highland mountains.

6. LECANORA TARTAREA. Thallus white-glaucescent,

membranaceous-cartilaginous or tartareous, areolate-tuberculose. Apothecia naked; margin tumid, becoming thin, often inflexed. (E. B. 156, var. *saxorum*.) The "Orn-mâssa" of Sweden and Norway.

A common montane and alpine species, growing on boulders and rocks in Highland districts and on Highland mountains. The thallus is frequently sterile, sorediiferous or isidioid; it is usually thick, friable, and mealy, its tubercles varying in size, but always densely aggregated. The apothecia are generally large, often confluent, and very irregular in form, having usually flexuose, thick, incurved margins; they may be concave or flattened. It appears to prefer granitoid rocks and exposed situations. We have found it in a sterile state, along with other subalpine or alpine species, on large micaceous boulders on the hills, at a slight elevation above the sea, around Perth. It is to be presumed that the Lichens have been developed subsequently to the removal of the boulders from their origin—probably the Dunkeld Highlands, fifteen miles off—to their present resting-places; hence this example would tend to indicate that the nature of the rocky habitat has frequently more to do than climate with the growth of some montane or alpine species. A variety grows sometimes on trees in alpine woods; and a

peculiar form, var. *frigida*, having a loose granulose thallus, grows on decayed moss, grass, or heather, on some of the Highland mountains. (E. B. 1879.) In the latter, as well as in the similar muscicolous form of *L. pallescens*, the thallus sends out papillæ, or spinuliferous branches.

The thecæ of *L. tartarea* are large, but indistinct and unispored; the spores, in appearance, resemble those of the preceding species, but are larger. This species yields a beautiful orchill, and, under the name of "Swedish" or "Tartareous Moss," is largely imported from Norway and Sweden by the London orchill-maker. Isidioid varieties or forms, in which the thalline tubercles are hypertrophied, appear to be richest in colorific matter. From this Lichen *Cudbear* was at one time largely manufactured in Scotland, and *Litmus* in Holland. When Cudbear-making flourished in Glasgow and Leith, the "Cudbear Lichen," so-called, was largely collected in the western Highlands and islands by the poor peasantry, who were thus able to earn in 1807, according to Hooker, fourteen shillings a week. In Derbyshire and the rocky parts of Cumberland and Westmoreland it was also at one time collected by the peasantry, probably for the London market; they sold it to the manufacturer at a penny a pound, and were able usually to gather twenty to thirty pounds a day.

The plant is very abundant in alpine districts throughout Britain, and might surely be collected for the London market at a cheaper rate than the same article from Sweden and Norway. Could the gathering of the "Cudbear Lichen" be revived in our highlands and islands, a great boon might be conferred on the inhabitants, who have within the last half-century also been deprived of another source of emolument—kelp-gathering,—and whom poverty now compels to emigrate to foreign shores. This Lichen has been much used by the peasantry of various parts of Britain and Scandinavia in the preparation of domestic dyes. The Scotch Highlanders manufacture Cudbear by macerating the powdered Lichen in putrid urine for some weeks, adding some kelp or salt, and when the requisite purple or crimson tint is obtained, forming the paste into balls or lumps with lime or burnt shells, and suspending it in bags to dry. When about to be used, it is powdered, and the powdered Lichen boiled in water with a little alum. This Lichen is the "Cork" or "Korkir" of many parts of the Highlands. In Shetland, along with the pigment prepared therefrom, it is called "Korkalett:" there it is always collected in May or June, or early in the spring or summer, as it is then richest in colorific principles; and it is popularly supposed that a slight admixture of *Cladonia*

rangiferina, Peltigera canina, or *Marchantia polymorpha* is sufficient to spoil it for dyeing purposes. The Swedes prepare from it a red dye, which they call "Bœttelet," and the Welsh peasantry use it in a similar way. This and the preceding species are widely distributed over the world, growing in the Arctic and Antarctic regions.

c. *Apothecia yellow.*

7. LECANORA VARIA (from *varius,* changeable). Thallus greenish-yellow, becoming ochroleucous, cartilaginous, rugose-granulose; hypothallus white. Apothecia innate or sessile, yellowish-flesh-coloured, becoming sometimes brownish or blackish, with a thin, erect entire margin, which sometimes becomes flexuose or crenulate, pulverulent, or covered by the thalamium. (E. B. 1549, var. *maculiformis;* E. B. 2547, var. *aitema.*)

A common and, as its name implies, a protean species, growing on trees, palings, and dead wood in lowland districts; some of its varieties, of which there are many, are montane or alpine. It was found by Saussure, Agassiz, and others, on the summits of the Alps. It is frequently abundant on the fences of fields and on roadsides. The thallus sometimes becomes pulverulent. The apothecia may be concave, flattened, tumid, or convex, minute or large, black and abortive; its spores resemble those of *L. subfusca.*

d. *Apothecia red.*

8. LECANORA RUBRA (*ruber*, red). Thallus whitish, leprose or subcartilaginous, verruculose or granulate-pulverulent. Apothecia from flesh-coloured becoming blood-red, concave; margin tumid, inflexed, crenulate.

An elegant species, not very common on trees in some parts of the Highlands, as about Ben Lawers, Perthshire.

9. LECANORA HÆMATOMMA. Thallus pale ochroleucous or whitish, tartareous-farinose. Apothecia innate, at length sessile, crimson or blood-red.

Not uncommon as a coating of rocks in many localities, lowland and subalpine. It is somewhat frequent in the neighbourhood of Edinburgh, as on Arthur's Seat and North Berwicklaw; around Perth it occurs on the hills aboye Kinfauns, and it incrusts the rocks about the Falls of Moness to such an extent, that Burns alludes to it when he sings in his 'Birks of Aberfeldy,'

"The *hoary* cliffs ascend like wa's."

10. LECANORA VENTOSA. Thallus pale greenish-yellow, tartareous, verrucose-areolate and pulvinate. Apothecia appressed, blood-red or brownish-red, resting on the thalline warts, frequently irregular in form; margin thin or thick, pale, entire, often flexuose. (E. B. 906, vars. *lecidina* and *abortiva*.)

Comparatively common on rocks and boulders, especially granitoid, in many parts of the Highlands, but a somewhat rare saxicolous species in lowland districts. Its spores, in the specimens we have examined, are unlike those of the preceding species, being fusiform, bulging in the centre, triseptate, and colourless, or somewhat intermediate in general characters between those of *Peltigera* and *Sticta*. An alcoholic solution of a Norwegian specimen gave a rich green reaction with ammonia, a reaction which we found in no other Lichen whose colorific capabilities we have examined. This species occurs in the Antarctic regions, North America, Australia, and in several other parts of the world.

Two foreign species of this genus, *Lecanora esculenta* and *affinis*, are of great interest, from having repeatedly, under extraordinary circumstances, served as the food of large numbers of men and cattle, in various countries lying between Algeria and Tartary. They are said at various times and in divers places to have appeared suddenly, covering with a layer, sometimes from three to six inches thick, large tracts of country; and the inhabitants, believing their origin to have been from heaven, have designated them a species of manna, and have imitated their flocks, in times of scarcity of food, by eating them. Some writers, speculating on their nature, have gone so far as to assert their identity with the

manna miraculously supplied to the children of Israel while journeying in the wilderness. Several "rains of manna," consisting of one or other of these Lichens, have been described by travellers as occurring in Persia and neighbouring countries. The manna is usually found in the form of small lumps, from the size of a pin's head to that of a pea or small nut, which are greyish or whitish, hard, irregular in form, inodorous, and insipid. Individual plants weigh from a few grains to about a couple of scruples when dry; the thallus bears no evidence of having, at any period of its growth, been attached to a base of support. And, singularly enough, analysis has failed to discover in it starch, though it has detected no less than 66 per cent. of oxalate of lime in some specimens; hence it has proved deleterious to sheep feeding on it in Algeria, and has only been used by man in extreme need. This Lichen-manna has fallen in the form of rain, or has been found suddenly covering tracts of country in Persia, the steppes of Tartary, the countries about the Altai and Caucasus, near Sebastopol and other parts of the Crimea, on Ararat, near Damascus, in Algeria, and in the African Sahara. As an illustration of the circumstances under which this manna-rain is said to fall, Anchercloi states that in 1829, during a war between Russia and Persia, a large tract of country round a town on the south-west shore

of the Caspian, whose inhabitants were in a state of famine, was suddenly covered by a Lichen which fell from heaven. The sheep were noticed to eat it with avidity; the idea immediately occurred to the famishing inhabitants that this substance might prove equally agreeable or nutritious to themselves, and accordingly it was converted into bread. A substance eaten by the Kirghiz Tartars under the name of "Earth-bread" would appear to be a different Lichen, inasmuch as it occurs as a crustaceous coating of the soil, cracking and separating in fragments when the ground becomes dry.*

Genus II. URCEOLARIA, *Ach.*

Gen. Char. Thallus uniform, usually greyish or whitish, sometimes rusty-coloured (by the absorption of peroxide of iron from the soil). Thalamium always naked, marginate, concave or flattish, black or reddish, somewhat separate from the margin of its exciple. (Name from *urceolus*, a little water-pitcher, in allusion to the form of the apothecium.)

1. URCEOLARIA CINEREA (*cinereus*, of an ash colour). Thallus tartareous, smoothish, greyish or whitish rimose-

* Eversmann, In Lichenem esculentem Pallasii: Wright, on *L. esculenta*, in American Journal of Science, 1847: Walpers, on *L. esculenta*, in Botanische Zeitung, Aug. 25, 1851: Berkeley, in Gardeners' Chronicle, 1849, p. 611, or Lindley's 'Vegetable Kingdom,' 3rd ed. 1853, p. 50 c.

areolate; hypothallus black. Apothecia at first seated in thalline areolæ, patellate and scutellate, black, naked, or greyish-pruinose. There are many varieties in which the apothecia are isolated or crowded, irregular in form, with a thick, flexuose, or unequal margin.

Not uncommon on rocks and stones of various kinds in lowland and subalpine districts; it is frequently the cause of the grey colour or crust of rocks and cliffs. Its spores, in the specimens we have examined, resemble those of *Physcia ciliaris* or *Parmelia stellaris*, but are smaller than either.

2. URCEOLARIA SCRUPOSA (*scruposus*, rugged). Thallus tartareous-farinose, whitish, greyish, or lead-coloured, areolate-verrucose or granulose, sometimes dissolving into a pulverulent mass; hypothallus white. Apothecia immersed, —younger concave, margin contracted or connivent, rugose; older flattened, patellate or scutellate, black, greyish-pruinose, the margin sometimes obsolete. (E. B. 1732, var. *vulgaris*; 266, var. *bryophyta*; 1954, var. *diacapsis*.)

A comparatively frequent species in lowland and subalpine districts, incrusting rocks, stones, dead wood, tree-trunks, the ground or moss. Saxicolous forms are sometimes isidioid; muscicolous varieties, like similar forms of *Lecanora pallescens* and *tartarea*, differ most from the others

in appearance. The young thallus often contains such an amount of oxalate of lime as to be quite gritty between glass slides; and under the microscope this salt may be detected in the form of its characteristic octahedral crystals. Its thecæ are long, slender, and linear; its spores comparatively large and very distinct. The latter are broadly oval or somewhat oblong, frequently with an irregular wavy or bulging margin, depending upon their cellular contents, which consist of a number of rounded cubical cellules, varying in size, arranged usually in six to ten horizontal rows, and sometimes in a distinctly double longitudinal series; they are thus of the class of spores termed cellular or muriform. When young they are pale-yellow, but when mature they become dark-olive or blackish or brownish-green. The spermogones are scattered over the thallus, and sometimes niched in the exciple of the apothecia; they are difficult of discovery, from the pale colour of the ostiole. They are oval or globular; their usually simple cavity is lined with straight sterigmata, and almost loaded with spermatia, which are linear, straight, and thicker than those of most Lichens.

3. URCEOLARIA CALCAREA (*calx*, lime). Thallus tartareous-farinose, whitish rimulose-areolate, often effigurate at circumference; hypothallus white. Apothecia immersed,


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flattish, black,—younger greyish-pruinose, then naked, with a thin, at length discrete, entire, proper margin; thalline border somewhat prominent, entire or rugose-crenate. The thallus is sometimes continuous or very slightly rimulose; the areolæ discrete, and the apothecia isolated or crowded, and punctiform. (E. B. 820, var. *concreta*, subvar. *multipuncta*.)

Not uncommon on rocks and stones, especially calcareous ones (hence its name), in lowland and subalpine districts, as on the Silurian rocks of the Malvern Hills. In some localities it is so peculiar to limestone rocks, that it might almost be considered diagnostic. In Wales, Shetland, and other parts of Britain, it has been used by the peasantry to yield a scarlet dye. We have found several of the Urceolarias to resemble the tartareous Lecanoras in their colorific properties, yielding like them fine qualities of orchill. The *Lecanora tartarea*, as formerly collected in the Western Highlands for Cudbear-making, was frequently mixed with this species.*

* For observations on the minute anatomy of Urceolaria, *vide* Dr. Schuchardt in 'Botanische Zeitung,' March 2nd, 1855, 'Zur Kenntniss der Gattungen Urceolaria und Lecidea.'

Nat. Ord. VIII. *LECIDEACEÆ.*

Fam. Char. Thallus crustaceous. *Apothecium* patellate, orbicular, concave, flat or tumid, solid.

Genus I. GYALECTA, *Ach.*

Gen. Char. Thallus uniform. Apothecium urceolate, immarginate, at first closed and nucleiform, afterwards variously dehiscent, the excipular border being elevated, discrete, coloured. (Named from γυαλός, concave, in allusion to the form of the apothecia.)

1. GYALECTA CUPULARIS (*cupa*, a cup). Thallus reddish-grey, becoming greyish-green when dry, leprose. Apothecia superficial, concave, radiate-dehiscent, brick or flesh-coloured; margin in younger contracted-rugose, whitish-subpulverulent. (E. B. 739.)

On stones and rocks, especially of a calcareous and arenaceous nature, and also sometimes on ground in various lowland and subalpine districts. Its thin thallus moulds itself accurately to the surface of the stones on which it grows. The spermogones may be recognized as small, somewhat spherical tubercles, with a broadened base, seated on and scarcely in the thallus; they are of a pale rose-colour, have a dense thick capsule, and are of a horny consistence; the

interior is divided into labyrinthine cavities. The sterigmata are very slender; the spermatia of great tenuity, and straight.

Genus II. LECIDEA, *Ach.*

Gen. Char. Thallus effigurate or uniform. Apothecia generally black, flattish, marginate, thalamium frequently becoming tumid and covering margin of exciple, which is generally carbonaceous and very black. Tissue on which thalamium rests commonly also carbonaceous, sometimes differently coloured. (Name from λεκός, a dish, and εἶδος, like, in allusion to the form of the apothecia.)

A large and important genus, including most of the small crustaceous Lichens of our rocks and walls,—those species which are generally the initial agents in the disintegration of our mountains and in the formation of vegetable soil. Many species appear destitute of a thallus, the dissociated elements of which however may be found sunk in, or incorporated with, the surface of the rock or tree on which they grow; some sink their apothecia deeply in the hardest rock.*

* For minute anatomy of species of *Lecidea, vide* Dr. Schuchardt, in 'Botanische Zeitung,' March 2, 1855.

** Thallus squamulose; squamules often aggregated into a variously plicate crust.*

a. *Squamules solitary or imbricate.*

1. LECIDEA DECIPIENS. Thallus brick-coloured, below and at margins white; squamules orbicular or sinuate-lobate, wavy, discrete or aggregate. Apothecia black within and without, globose, marginal. As the plant becomes old the thallus and apothecia sometimes become white.

On heathy or gravelly soil in different parts of Scotland and England; not very common. Its spermogones are not abundant, but are easily recognized, when they are present, on the centre of the squamules, by their minute stellate pores. They are immersed, globular, divided interiorly into several plicate sinuses; their sterigmata are linear, very slender and crowded; their spermatia numerous and straight.

b. *Squamules aggregated into a gyrose or rugose-plaited crust.*

2. LECIDEA CÆRULEO-NIGRICANS (*cæruleus*, blue or green, and *nigricans*, blackish). Thallus blackish-green, often whitish or greyish-pruinose, cartilaginous; squamules aggregated into a bullate or rugose-plicate crust. Apothecia black without, white within, naked; margin prominent, often flexuose. The thallus usually sends upwards erectish, stem-like, ramose

squamules, inflated above, fibrillose and yellowish below. The apothecia are among the largest found in the genus *Lecidea*, and are generally flat, rarely tumid. (E. B. 1139.)

On ground, rocks, and in rock-fissures, on various Highland mountains, but not common.

c. *Squamules aggregated into a radiose-plicate crust.*

3. LECIDEA CANESCENS (*canesco*, to become white or hoary). Thallus glaucous, greyish or whitish; peripheral squamules sinuate-laciniate, margins rotundate-lobate; centre rugose, often becoming pulverulent. Apothecia black within and without; younger greyish-pruinose, sometimes crowned by thallus.—Individual specimens generally have a diameter of half an inch or an inch, but the plants are frequently confluent, forming large, irregular patches. Apothecia are very rare. (E. B. 582.)

Common on trees and stones in lowland regions; it is abundant in the woods and on roadside walls in the neighbourhood of Perth, almost always in a sorediiferous or pulverulent, and never in a fertile, state. Its spermogones resemble those of some Parmelias; they are distinguished on the thallus as small black points or cones, and are immersed, have an oval figure, a very narrow ostiole, and a simple cavity. The sterigmata are almost solid, very narrow, articulated,

irregular and ramose; the spermatia straight, and very numerous. This species is made the type of a new genus by some recent authors,—the genus *Buellia* of De Notaris, the *Diplotomma* of Flotow.

** *Thallus distinguished by a persistent, black, delicately fibrillose hypothallus, and by coloured areolæ, which are sometimes aggregated into a rimose-areolate crust, bounded by a black margin.*

4. LECIDEA GEOGRAPHICA (γῆ, the earth, and γραφή, a drawing). Areolæ yellow, flat or convex, discrete or contiguous. Apothecia arising from hypothallus, crowded between areolæ, black without and within, margin of cupular exciple thin. The areolæ vary much in size and colour; sometimes they are crowded, contiguous or coalescing, forming a more or less chinky crust, or they are scattered interruptedly over the hypothallus; they may be tumid, verrucæform, prominently marginate, or pulverulent. The apothecia may be flat or tumid, sometimes urceolate. Named from its fancied resemblance to a coloured map. (E. B. 245, var. *alpicola*.)

The variety *atro-virens*, which has small, tumid, discrete areolæ, and flat or tumid apothecia, is very common on rocks and stones, especially granitoid (quartzose and micaceous),

on all our Highland mountains and in many localities in lowland and subalpine regions. Around Perth it abounds on old walls, built of boulders from the neighbouring Grampians. It frequently grows on pure milky quartz, and is then from the contrast of its blackish-green colour a very pretty object. Its spores are somewhat large, oval or oblong, marked by irregular bulgings, dark-brown, and contain generally four oblong rounded cells, which give the spores an obscurely triseptate character; they vary much in form and size, are generally so dark in colour as to be indistinct in their structure, but resemble in characters the spores of certain Verrucarias. This species occurs abundantly in the Arctic and Antarctic regions, and it is the last form of vegetable life which has been met with by travellers on the greatest elevations hitherto reached on the Andes and Himalayas.

**** Thallus uniform, simple.*

a. *Apothecia black or blackish-red.*

† *Thallus tartareous.*

5. LECIDEA CONFLUENS (*confluo*, to flow or run together). Thallus smoke-coloured or grey-whitish, very slightly rimulose-areolate. Apothecia very black, naked, never greyish-pruinose, appressed, flat, thinly margined, rarely convex,

frequently confluent (several apothecia aggregated into one).

Somewhat common on rocks and stones on our lowland as well as highland hills, as on the Pentlands, near Edinburgh, and on Ben Lomond. It attains the summit of the Alps, having been found by Saussure on the top of Mont Blanc, and by Agassiz at a height of 12,850 feet on the Jungfrau. Like various Urceolarias and Gyalectas it sometimes has an ochrey colour, derived from the peroxide of iron in the substance on which it grows.

b. *Thallus leprose, granulose or pulverulent.*

6. LECIDEA PUNCTATA (*punctum*, a prick or point). Thallus glaucous or ash-grey, leprose or cartilaginous, sometimes rimulose-areolate and rugulose. Apothecia black, sessile, flat, with prominent thin margins, rarely convex, and immarginate.

A very common corticolous species in lowland and subalpine districts: it grows most frequently on the fir tribe, on the oak, beech, and other trees, and on the wooden fences of fields. On dead wood it sometimes occurs in a degenerate form. In one of its commonest varieties, var. *parasema*, the crust is thin, equal, and bounded by the black hypothallus, or effuse; the apothecia are largish, flat or convex. In

another variety, *punctiformis*, whose favourite habitat is frequently the Scotch fir, the crust is also very thin, and the apothecia flat or convex, but minute and point-like. (E. B. 1851 and 2699.) This species is apt to be confounded with others having a similar or an obsolete crust, and black apothecia. Its spores vary considerably in characters; those we have seen are usually oval or oblong, bi-cellular, larger than those of *Parmelia parietina*, and resembling in general appearance the spores of *Ramalina*. The protoplasm from which they are developed generally contains a considerable amount of oil-globules.

7. LECIDEA SANGUINARIA (*sanguis* or *sanguen*, blood). Thallus glaucous or whitish-grey, leprose, covered with granules or globules of a similar colour, sometimes aggregated into a tartareous crust. Apothecia black, often confluent, naked, becoming convex. Thalamium resting on a blood-red stratum (easily seen on section of the apothecium).

A common corticolous and saxicolous species in lowland, as well as subalpine districts. It closely resembles the preceding species, from which and others it may always be distinguished by the sub-thalamial red stratum. The spores are large, ellipsoid or elongate-oval, sometimes oblong, with truncate or tapering and horn-like extremities, pale yellow

or colourless,—having finely granular or transparent contents. They bear a resemblance to those of *Pertusaria*, but are more irregular in form; this irregularity is usually due to the adhesion of abortive spores, which are so common in this species, that of eight spores in each theca only one or two usually attain maturity and become fertile. The sterile or abortive spores of Lichens are sometimes indistinguishable in size or colour from fertile mature cells; but they will generally be found partially or wholly deficient in granular or oily protoplasm, which is essential to their germination.

b. *Apothecia variously coloured, within white.*

† *Apothecia variegate.*

8. LECIDEA SPHÆROIDES (*sphæra*, a sphere or globe). Thallus leprose, white, covered with greenish granules, sometime deliquescing into a pulverulent mass. Apothecia white, becoming yellow, pale red, black-pruinose, at length black, flat, marginate, or convex and immarginate, solitary, aggregate or confluent. (E. B. 1683, var. *effusa*; 2217, var. *muscorum*; 2547 and 2699, var. *viridescens*.)

In some of its numerous varieties common in lowland and subalpine districts, growing on trees, dead wood, decayed moss and heather, and the ground; some forms are peculiar to moist lowland woods, others to Highland mountains.

Several species of this section were classed by Fries and others in a separate genus, *Biatora* (*βιατορ*, a small jug or bowl), distinguished by the apothecium being variously coloured, instead of black.

†† *Apothecia red.*

9. LECIDEA PINETI (*pinetum*, a wood of pine-trees). Thallus greyish-green, leprose; apothecia minute, sessile, flesh-red, flat or concave, becoming urceolate from the falling out of the thalamium; margin prominent, thin.

An elegant species, common on the fir, and sometimes beech, in lowland and subalpine woods. Its spores resemble those of the following species, but are much smaller.

10. LECIDEA ÆRUGINOSA (*ærugo*, verdigris). Thallus whitish, leprose, covered with æruginose granules; apothecia rose or flesh-coloured, appressed, sessile or very slightly pedicellate, flat, marginate, somewhat crowned by thallus, at length tumid and immarginate. (E. B. 372.)

A common species on heaths in lowland and alpine districts, growing on moist peaty soil, and about gravel-pits. Its apothecia are among the largest met with in the genus *Lecidea*; they are frequently irregular in shape, and crowded or aggregate. The plant is more familiar under its old name, *Lichen ericetorum* or *Lecidea icmadophila*. Its thecæ are

long, slender, linear, eight-spored; the spores are of medium size, ellipsoid or fusiform, uniseptate, pale-yellow. In the young state of the spore there are sometimes several septa at irregular intervals, or none are visible, the cell being simple.

11. LECIDEA FERRUGINEA (*ferrugo*, iron-rust). Thallus whitish or greyish, leprose, covered with granules or warts of similar colour; apothecia rusty-red, sessile, flat, marginate, at length convex and immarginate.

A common corticolous and saxicolous species; in the neighbourhood of Perth it occurs on the beech and other forest-trees, and on micaceous stones in old roadside walls. In the commonest form the apothecia are largish, with a thick, entire or flexuose margin, sometimes crowned by the thallus. The spores are almost identical with those of *Parmelia parietina*. The spermogones are not very frequent; they are isolated or grouped, obtuse, dark reddish-brown tubercles, whose internal tissue is white, and very solid; their cavity branches into several sinuses. The sterigmata consist of almost solid cellules, and are sometimes ramose; the spermatia are of great tenuity.

c. *Apothecia yellow.*

12. LECIDEA LUTEA (*luteus*, pale yellow). Thallus greyish-green, leprose; apothecia yellow, thinly margined, sessile, flat. (E. B. 1263.)

Not very common, on trees in various localities in England and Ireland.

13. LECIDEA AURANTIACA (*aurantiacus*, of an orange-colour). Thallus yellowish, leprose or tartareous; hypothallus white. Apothecia orange-coloured, thinly margined, younger crowned by hypothallus. The thallus is sometimes evanescent. The apothecia may be innate or sessile, flat or convex, with a more or less prominent margin.

Comparatively common on various trees, as the poplar and willow, and on various rocks and stones,—especially calcareous, arenaceous, and granitoid,—in lowland, more rarely in subalpine regions.

Nat. Ord. IX. *GRAPHIDEACEÆ.**

Fam. Char. Apothecia oblong or lirellate. *Thalamium* at first connivent or veiled, oblong, subcanaliculate, normally having a proper or thalline exciple, or both. (Name from γραφή, writing, in allusion to the resemblance of the apothecia,—which are frequently irregularly stellate or radiate,—to ancient hieroglyphics or written characters. For the same reason the *Graphideæ* are popularly designated "Letter Lichens," or "Scripture-worts.")

* BIBLIOGRAPHY :—Leighton, Monograph of the British Graphideæ, in the 'Annals of Natural History,' 1854, also published separately : Chevalier, Histoire des Graphidées, 1824, and in the 'Journal de Physique,' Feb., 1822 : Dufour, Révis. du Genre Opegraphe, etc., in the 'Journal de Physique,' 1818.

A peculiar, common, and extensively diffused family, attaining its maximum development in the Tropics, and decreasing in numerical distribution towards the Poles; in Lapland only one species exists. Their habitat is usually the smooth bark of forest-trees, but some species are saxicolous. From their minuteness and protean character they are a difficult family to study; but Leighton has lately done much towards the deciphering of these hieroglyphics of Nature,—as Layard and Rawlinson have discovered the signification of the graven characters on the stones of Nineveh,—and has produced a valuable monograph, which is the basis of the characters of the genera and species as here given.* The *Graphideæ* generally appear destitute of a thallus. The lirellæ may frequently be said to constitute the plant; but the dissociated elements of the thallus may usually be discovered expanded in the tissue of the bark on which it grows. The spores of the species and genera vary greatly in character; but in general they may be characterized as elongated, narrow and polycellular or polyseptate. They are frequently linear, fusiform, oblong or clavate, margined, containing rounded or irregular cellules, which are some-

* We do not however express an unqualified approval of Leighton's classification; for we cannot help thinking that he has divided, or split up, the *Graphideæ* to an unnecessary extent.

times arranged in a single vertical series like a row of beads, or transversely in several rows.

Genus I. OPEGRAPHA, *Ach.*

Gen. Char. Apothecia lirellate, sessile. Perithecium carbonaceous, entire,—that is, surrounding the sides and base of thalamium, which is rimæform or canaliculate, having a prominent, proper margin. Thallus crustaceous or membranaceous. (Name from ὀπή, hollow, and γραφή, writing; also popularly called "Chink-wort.")

* *Saxicolous species.*

1. OPEGRAPHA SAXATILIS. Thallus pulverulent, chalky-white; lirellæ prominent, rigid, straight or stellate-divergent, tapering towards each extremity. Spores eight in each theca, obtusely or subclavately fusiform, five to seven-septate; central cell largest, pale yellow. (E. B. 1790.)

Common on various rocks and stones, as limestone and sandstone, as well as on mortar, in various parts of Britain. The spermogones may sometimes be discovered as black points on the surface of the thallus; they are globular, unicellular, with a thin brownish capsule. The sterigmata are short and linear; the spermatia straight, of great tenuity, and very numerous.

2. OPEGRAPHA RUPESTRIS (*rupes*, a rock). Lirellæ oblong or ovate, deformed, short, obtuse, variously branched, wider at one extremity; thecæ eight-spored; spores clavate, rounded at each end, triseptate, pale yellow. (E. B. 2345.)

On calcareous and arenaceous rocks and stones in various parts of Britain.

** *Corticolous species.*

3. OPEGRAPHA VARIA. Thallus pulverulent, white; lirellæ prominent, sessile, round, oblong, elliptic, or elongated and attenuated at each end. Thalamium canaliculate or dilated in the middle, or plane and convex; proper margins prominent, inflexed, sometimes subevanescent; thecæ eight-spored, irregularly obovate or obovate-fusiform, five-septate; the central cell larger, hyaline, pale yellow. (E. B. 1890, var. *notha*; 2280, var. *tigrina*.)

A common species on the oak, beech, elm, and other trees in our forests. Its name implies its changeable character: there are several varieties or states, depending on alterations in the character of the lirellæ. Its spermogones are somewhat similar to those of *O. saxatilis*.

4. OPEGRAPHA ATRA. Thallus very thin, forming smooth, pale yellow or whitish ocellate patches; lirellæ densely crowded towards the centre of the patch, sessile, depressed,





lying in all directions or subparallel, linear, generally simple or confluent, flexuose. Thalamium narrow, uniform; proper margins thick, elevated, wavy. Thecæ eight-spored. Spores very minute, obovate, somewhat pointed at extremities, tri-septate, pale yellow. (E. B. 1753.)

A common species on the smooth barks of the ash, oak, ivy, hazel, currant and other trees or shrubs in various parts of Britain. In germinating, the germ-filaments generally proceed from the terminal contained cellules of the spore, and thereafter the central ones sometimes send forth similar delicate tubular processes.

5. OPEGRAPHA VULGATA (*vulgatus*, common). Thallus effuse, cartilaginous-membranaceous, cracked and scaly, greenish-white; lirellæ prominent, sessile, variable in size,—shorter ones roundish or oblong, longer ones slender and linear, simple, wavy and shining or greasy. Thalamium rimæform, uniform; proper margins thick, very round and inflexed. Spores fusiform, five-septate, pale yellow. (E. B. 1811, var. *vulgata*.)

Common on the fir, ash, birch, oak, elm, apple, holly and other trees in our woods and on our roadsides.

Genus II. GRAPHIS, *Ach.*

Gen. Char. Apothecia lirellate, immersed. Perithecium carbonaceous, covering only sides and not base of thalamium, which is canaliculate, having a proper margin and an accessory thalline margin. Thallus crustaceous or membranaceous. (Name from γραφίς, a design or sketch.)

1. GRAPHIS SCRIPTA (*scriptus*, written). Thallus thin, membranaceous, continuous, even; lirellæ emergent, slender, contracted here and there, extremities acuminate; proper margin thin, elevated, wavy, and crisped; thalline margin membranaceous. Thalamium rimæform, naked. Spores oblong or oval, margined, each containing eight to ten horizontal rows of subrotund, margined, yellow cellules.

A common species, growing on the smooth barks of various forest and roadside trees, as the oak, ash, elm, birch, and hazel. The two following species are also common in similar habitats, and closely resemble it in general characters.

2. GRAPHIS PULVERULENTA has a subtartareous, rugulose thallus. Lirellæ subsessile, broadish, extremities cuspidate; proper margin thick, uniform; thalline margin elevated, tumid: thalamium broadly canaliculate, pruinose. (E. B. 1754.)

3. GRAPHIS SERPENTINA. Lirellæ immersed, slender, of same width throughout, extremities obtuse: thalamium canaliculate, naked, or pruinose. Spores linear, margined, rounded at the ends; each containing eight to ten transversely-oval, margined, yellow cellules. (E. B. 1755, var. *eutypa*; 2301, var. *recta*.)

Genus III. HYMENODECTON, *Leight.*

Gen. Char. Apothecium lirellate, immersed. Perithecium a very thin, black, cartilaginous membrane, surrounding sides and base of thalamium, which is broad, plane, having a very slender proper margin and an accessory thalline margin. Thallus crustaceous or membranaceous. (Name from ὑμήν, a membrane, and δεκτικός, fitted to receive, in allusion to the structure of the perithecium.)

1. HYMENODECTON DENDRITICUM (δένδρον, a tree). Thallus tartareous, pulverulent, determinate; lirellæ branched in a pedate-radiate manner; thalline margin prominent, rugose. Thalamium plane, dilated, pruinose. Spores linear, margined, rounded at ends, each containing about eight transversely-oval, margined cellules. (E. B. 1756, var. *Smithii*.)

On the beech in lowland forests in various parts of England; not very common.

Genus IV. CHIOGRAPHA, *Leight.*

Gen. Char. Apothecium lirellate or subdisciform, sessile. Perithecium carbonaceous, surrounding the sides and base of a plane, broad thalamium, which has a proper, and an accessory, thalline margin. Thallus membranaceous. (Name from χιών, snow, and γραφή, writing, in allusion to the white, powdery, thalline margin.)

1. CHIOGRAPHA LYELLII. Thallus smooth, wavy, determinate; lirellæ prominent, oblong or linear-oblong, simple, curved; proper margin narrow, prominent; thalline margin elevated, white, pulverulent. Thalamium plane, broad, pruinose. Spores linear, margined, rounded at ends, each containing about seven or eight transversely oval, margined cellules. (E. B. 1876.)

On the oak in the New Forest, Hampshire, and other parts of England.

Genus V. AULACOGRAPHA, *Leight.*

Gen. Char. Apothecium lirellate, subimmersed, prominent. Perithecium carbonaceous, dimidiate, palmatifid, the base naked.

Thalamium rimæform, closed, having a proper, longitudinally furrowed, and an accessory thalline, margin. Thallus membranaceous. (Name from *αὖλαξ*, a furrow, in allusion to the structure of the proper margin.)

1. AULACOGRAPHA ELEGANS. Thallus subtartareous, orbicular, granulated or rugose, determinate; lirellæ erumpent, sessile, oblong or linear-elongate, simple, straight or curved; proper margin thick, tumid, prominent; thalline margin thin, membranaceous. Spores linear-elongate, with a broad, membranaceous border, each containing eleven to thirteen transversely oval, margined cellules; they are among the largest and most handsome spores to be found in the family. (E. B. 1812.)

Common on various trees, but finest on the holly in various lowland woods.

Genus VI. LECANACTIS, *Eschw.*

Gen. Char. Apothecium lirellate or subdisciform, immersed. Perithecium carbonaceous, entire; thalamium plane, open, pruinose, having a proper margin. Thallus crustaceous. (Name from *λεκάνη*, a dish, and *ἀκτίν*, a ray, probably from its affinity, in regard to its fructification, to the genus *Lecidea*.)

1. LECANACTIS LYNCEA. Thallus tartareous, pulverulent,

white; lirellæ oblong or linear-oblong, rounded at each end, simple, curved; proper margin stout, elevated, wavy; thalamium flat, dilated, pruinose. Spores fusiform, seven-septate, pale yellow. (E. B. 809.)

On old oaks, and on oak timber long exposed to the weather, in various parts of England. It closely resembles in general appearance the corticolous forms of *Lecidea alboatra*, var. *corticola*, from which however its spores will distinguish it. Some authors regard many of the *Graphideæ* as deformed *Lecideas*, and assert that in temperate climates *Opegrapha* frequently reverts to its normal type *Lecidea*.

Genus VII. PLATYGRAMMA, *Leight.*

Gen. Char. Apothecium lirellate, subsimple or radiate. Perithecium none; thalamium free, plane, open, naked, without any margin. Thallus crustaceous. (Name from πλατύς, broad, and γράμμα, a letter.)

1. PLATYGRAMMA HUTCHINSIÆ. Thallus minutely cracked; lirellæ immersed in elevated thalline verrucæ, oblong or elongated, simple or branched, straight or flexuose; thalamium plane, dilated, naked. Spores fusiform, five to seven-septate, pale yellow.

On shady rocks near the ground, in various parts of England and Ireland; not common.

Genus VIII. ARTHONIA, *Ach.*

Gen. Char. Apothecium roundish or difformed, tumid, innately sessile, covered with a subcartilaginous membrane, within subgelatinous. Perithecium none. Thalamium nearly plane, not bordered, black, rough. Thallus cartilaginous-membranaceous. (Name from ἄρθω, or properly ἄρδω, to sprinkle, in allusion to the apothecia (hence called *Ardellæ*), resembling spots sprinkled over the thallus.)

1. ARTHONIA ASTROIDEA (ἄστρον, a star). Thallus thin, membranaceous, smooth, scaly, white, cream-coloured or olive, limited; ardellæ innate, clustered, substellate or radiate. Thalamium blackish, plane, rough. Spores linear-clavate, rounded at ends, triseptate. (E. B. 1847.)

Common on the smooth bark of forest-trees.

2. ARTHONIA SWARTZIANA. Ardellæ subsessile, clustered into irregular angular or subradiate shapes; thalamium black, plane, cracked. Spores broadly obovate, triseptate. (E. B. 2079.)

Common on the smooth bark of the ash and other forest-trees.

Genus IX. CONIOCARPON, *DC.*

Gen. Char. Apothecium (an ardella) appressed, rotundate-deformed or elongate, sessile, covered with a subcartilaginous membrane, which ultimately breaks up into a fine powder; perithecium none. Thalamium plane, depressed, not bordered, pruinose. Thallus crustaceous. (Name from κόνις, dust, and καρπός, fruit; the pulverulescence of the apothecia being the only respect in which it differs from the preceding genus.)

1. CONIOCARPON CINNABARINUM (*cinnabaris*, vermilion). Thallus filmy, thin, greyish, determinate; ardellæ clustered, shapeless, solid. Thalamium lurid and pruinose, or powdery, and of a bright vermilion colour. Spores obovate-clavate, rounded at ends, four-septate, upper cell largest, pale red. (E. B. 981, 2151.)

Somewhat common on the smooth bark of various trees, as the oak, ash, and hazel.

Nat. Ord. X. *CALICIACEÆ.*

Fam. Char. Thallus crustaceous, normally sending upwards vertical solid stalks. *Apothecium* capitate, floccose-pulverulent, either seated on a carbonaceous, turbinate, proper exciple or fixed directly on extremity of stalk.

Genus I. CALICIUM, *Pers.*

Gen. Char. Apothecium stipitate, rarely sessile or substipitate, concave, flattened or lentiform. Exciple carbonaceous, orbicular, flat or turbinate.* (Name probably from *calix*, a goblet, in allusion to the form of the apothecia.)

The species of this family are almost peculiar to dead wood, and are distinguished by the filiform or hair-like stalk which supports the button-like or globose fruit. The thallus is usually leprose, whitish, granulose, sometimes obsolete; one species, *C. tigillare*, is distinguished by its continuous, thickish, green thallus. In respect to its fructification, this genus closely resembles *Sphærophoron*. In both, the spores accumulate on the surface of the thalamium, forming, along with the *débris* of their thecæ and protoplasm, the chief elements of the blackish dust which covers the apothecium. In both, the spores are generally agglomerated in linear series by means of a viscid protoplasm; and, as they appear destitute of any thecal covering, except inferiorly, where the theca is found as a tapering filiform pedicle,

* Fresenius, on this genus, in 'Regensburger Flora,' 1848, and in Bayrhoffer's Uebersicht der Moose: Lebermoose und Flechten des Taunus, 1849: De Notaris, Frammenti Lichenografici di un lavoro inedito, 'Abbozzo di una nuova disposizione delle Caliciée,' Giorn. Bot. Ital. Ann. 2.

it has been supposed that they attain maturity externally to the theca, or are what have been denominated "naked spores." It is probable however that this phenomenon is more apparent than real. The thecæ are narrow, linear, and very delicate. In progress of the growth of the spores they frequently become so closely incorporated with their contents as to be inseparable and indistinguishable therefrom; in rare cases however they are found containing a linear series of mature spores. The spores of the *Calicia* are among the smallest of Lichen-spores; they are either simple or bilocular and usually dark-coloured. Several species of this family, from their great resemblance, were once classed under the genera *Mucor* and *Trichia* of the Fungi.

* *Apothecia (thalamium) black.*

† *Apothecia sessile or substipitate.*

1. CALICIUM TURBINATUM (*turben*, the toy called a top). Apothecium concave or flat; base stipitiform; exciple pyriform or turbinate, externally shining; margin thick, inflexed, paler. Spores small, spherical, simple. (E. B. 2520.)

Always parasitic on *Pertusaria communis*, and common in some lowland woods. Its spermogones are to be looked for with the lens, on the thallus of *P. communis*, in the form of small black spots scattered among the apothecia. They are

covered with a transparent membrane, which appears continuous with the cortical layer of the plant upon which it grows. The sterigmata are linear, almost simple. The spermatia are much curved like those of *Lecanora subfusca*, of extreme tenuity, and acrogenous.

†† *Apothecia stipitate.*

2. CALICIUM NIGRUM (*niger*, black or dark). Thallus white, leprose, covered with pale, æruginose or ashy-grey, deliquescent granules. Apothecium black, flat or tumid; exciple turbinate, and, along with stipe, black, naked. There are several varieties, depending chiefly on the thickness and length of the stipe, which in some is short and strong, in others longer and filiform; on the degree of granulosity and size of the thallus; and on the form of the apothecium, which in some is globose, and in others the thalamium becomes protruded to such an extent as to give to the fructification the appearance of a painter's brush. Its spores are bilocular. (E. B. 414, var. *sphærocephalum;* 2503, var. *curtum;* 2462, var. *pusillum.*)

On the bark of various of the fir tribe, and on putrid trunks in lowland woods, but not frequent.

** *Apothecia (thalamium) brown.*

3. CALICIUM CHRYSOCEPHALUM (from χρυσός, gold, and

κεφαλή, the head). Thallus white, leprose, covered with citron-yellow granules, which are frequently aggregated into a verrucose crust. Stipes slender, often elongated, black, frequently of a greenish tinge; exciple turbinate, black, in young state yellowish- or greenish-pruinose; spores simple. There are several varieties, depending chiefly on the length and thickness of the stipes, and on the size and the arrangement of the thalline granules.

On the rough bark of trees, and on decayed wood in lowland forests.

Genus II. CONIOCYBE, *Ach.*

Gen. Char. Apothecium spherical, stipitate, having no proper exciple. (Name probably from κόνις, dust, in allusion to the pulverulescent apothecium.)

1. CONIOCYBE FURFURACEA. Thallus sulphur-yellow, leprose-pulverulent. Apothecia pale brown, stipes black, both at first sulphureous-pulverulent.—There are several varieties, depending on the character of the stipes, which are most frequently elongated and filiform.

On the bark and roots of trees, on ground and on rocks in shady damp parts of lowland and subalpine woods; not common.

Nat. Ord. XI. *CLADONIACEÆ.*

Fam. Char. Thallus crustaceous or microphylline, sending up vertical, solid or hollow, simple or ramose, stems. *Apothecia* solid, turbinate or spherical, normally stipitate, destitute of a proper exciple, or having a scyphuliform one. (Name probably from κλάδος, a branch or twig of a tree, in allusion to the form of the vertical thallus.)

Genus I. STEREOCAULON, *Schreb.*

Gen. Char. Thallus taftareous, granulose. Stipes solid, simple or ramose, having a dense, leathery cortical layer, often covered with wart-like, granulose or squamulose growths. Apothecia cephaloid, immarginate, having no proper exciple, brown, solid, seated on the extremity of the stem or of its dilated ramules. (Name from στερεός, solid, and καυλός, a stem.)

Its fructification approximates this genus to *Lecidea.* Its vegetative system, along with that of *Usnea, Cladonia,* and *Sphærophoron,* more nearly resembles the general appearance of phanerogamic plants than any other Lichen-genera. The spermogones in this genus, in position, resemble those of *Cladonia.* Those of *S. paschale* are to be looked for, in the form of small brown tuberculose granules, near the apothecia. The spermatia are straight or slightly curved and linear.

* *Minor forms; stipes somewhat simple; thallus persistent.*

1. STEREOCAULON QUISQUILIARE (*quisquiliæ*, the smallest twigs of shrubs). Thallus cæspitose, floccose-pulverulent, pale æruginose; stipes flaccid, slender, granulate-pulverulent above, denudate below, simple or divided. Apothecia lateral, crowded.

A very minute, delicate form, growing on the ground and on damp shady rocks in the vicinity of waterfalls. Near Perth it occurs in the Den of Balthayock and in various other glens or ravines among the Sidlaw Hills. It is more familiar under its old name, *S. nanum*.

** *Major forms; thallus subevanescent; stipes very ramose.*

2. STEREOCAULON PASCHALE. Stipes cæspitose, somewhat strong, compressed and smooth, covered with granulate and crenate, conglomerate squamules. Apothecia mostly terminal, flat, often aggregated.

A very common saxicolous species in highland districts, growing usually in large, dense tufts. It is widely distributed over the world, occurring in the Arctic and Antarctic regions, on the Himalayas, in South America, and other foreign countries. It has been observed to be the first plant

which grows on the bare volcanic lava of Vesuvius and Ischia. In some parts of northern Europe it is eaten by game and other wild animals; and in Lapland it is often used by the reindeer as a substitute for *Cladonia rangiferina*. It is probable therefore that its thallus contains, in slight degree, starchy matter. Its spores are fusiform, elongated, triseptate, and pale yellow, resembling those of *Peltigera*.

3. STEREOCAULON DENUDATUM (*denudo*, to make naked) differs in its stipes being slender, angulose, attenuated, sparingly branched, verruculose-squamulose above, naked and smooth below. Apothecia usually lateral, small, aggregated.

Also a saxicolous species, but much less common than the preceding. It occurs in the Antarctic regions, on the Swiss Alps, Mexican Andes, and in other parts of the world.

Genus II. BÆOMYCES, *Pers.*

Gen. Char. Thallus tartareous. Stipes solid, destitute of a cortical layer, simple or divided. Apothecia capitate, immarginate, velate, becoming spongy and araneose within, terminal on stipe. (Name from βαιός, small, and μύκης, a mushroom, from its resemblance to various small fungi. This genus bears the same structural resemblance or natural affinity to *Cladonia* and *Stereocaulon* that *Calicium* does to *Sphærophoron*.)

1. Bæomyces roseus (*roseus*, rose-coloured). Thallus white, leprose-tartareous, verrucose. Stipes terete, somewhat short, of similar colour to thallus. Apothecia rose- or flesh-coloured.*

Not uncommon on argillaceous soils on hill-heaths. The thallus sometimes becomes isidioid,—the stipes sterile, and ventricose at the apex. Its thecæ are long, linear, and slender; its spores fusiform, elongated, simple, and pale yellow.

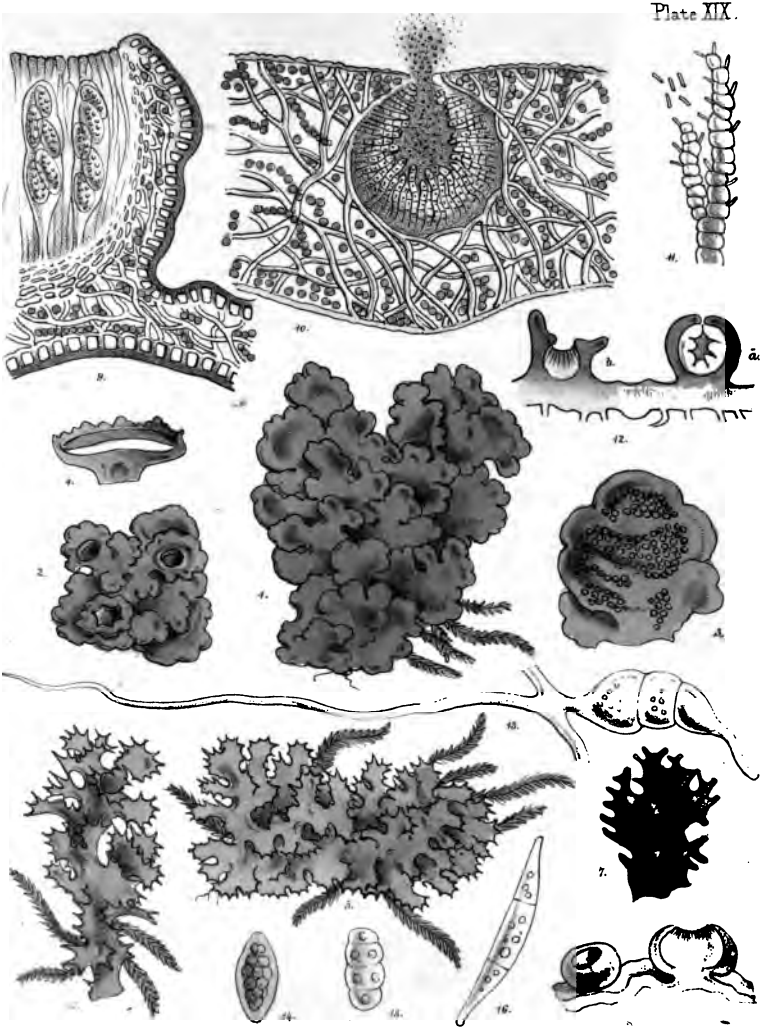
Genus III. CLADONIA, *Hill.*

Gen. Char. Thallus microphylline, sending up vertical, hollow stalks (*podetia*), some of them turbinate or tubæform, and terminating in a funnel or cup-shaped dilatation (*scyphus*); others cylindrical, simple or ramose, the extremities subulate or bearing the apothecia. Apothecia orbicular, submarginate; becoming at length inflated, cephaloid, immarginate; empty, seated normally on the margins of the scyphi or on the extremities of the cylindrical podetia. Proper exciple minute, ventricose, becoming concealed by the protuberant, reflexed thalamium.†

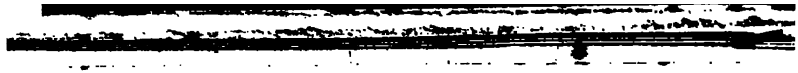
One of the most polymorphous and protean of Lichen-

* For minute anatomy *vide* Küttlinger in 'Botanische Zeitung,' 1845, pp. 577–584.

† For minute anatomy *vide* 'Botanische Zeitung,' March 23, 1855.



Arnott, Brooke Imp



genera, and one especially liable to puzzle the student in the determination of species. The surface of the podetium is sometimes covered with a green, granulose powder (gonidia), with irregular, wart-like granules, or with horizontal squamules; it is frequently lacunose, or it may have a carious, eroded, or cancellated appearance. Sometimes the podetium is divided superiorly into a number of irregular, short ramules, which may be fertile or sterile. The scyphi are usually closed by a membrane or diaphragm. The margin is entire or variously divided and toothed; sometimes it sends up a number of little stalks or ramules which serve as pedicles for the fructification. The apothecia are sometimes seated on the diaphragm, on the margin of the scyphi, directly or on its pedicle-like prolongations, rarely on the thalline squamules, or on the curvatures of the podetium; they may be solitary or aggregate, separate or symphycarpeous. From possessing a vertical as well as a horizontal, a secondary as well as a primary, thallus, the Cladonias rank among the highest typical forms of Lichens. The podetium may be regarded as a modification by involution of the simple thalline foliole or squamule. A similar modification of the leaf frequently takes place in the Phanerogamia, as for instance in the pitcher of the so-called Pitcher-plant. This

analogy renders the fistulose podetium, in the opinion of some authors, of superior rank or value in classification to the solid branched stipe of *Stereocaulon* and *Sphærophoron*. The thecæ and paraphyses in this genus are very small and indistinct. The spores vary little in different species, except in size; they are usually very minute,—among the smallest of lichen-spores,—ellipsoid, oval, or oblong, simple and colourless or very pale yellow. The spermatia also are similar throughout the species. The colour of the apothecia is generally scarlet or brownish, in both cases depending, according to chemists, on the oxidation, or other reactions and metamorphoses, of the colorific principle termed *Usnic acid*, in combination with bases. When dry, the podetia are often very friable, crumbling into dust by the slightest pressure; but moisture immediately renders them again quite flaccid. In their rudimentary or abortive state the *Cladoniæ* often present the characters which we have described under the genus *Lepraria*.*

* *Turbinate podetia scyphiferous; cylindrical ones entire (or imperforate) at axils of ramules.*

† *Apothecia scarlet.*

1. CLADONIA EXTENSA (*extendo*, to dilate). Podetia at

* Hampé on the Cladonias of the Hartz, in the Annales des Sc. Nat., vol. ix.

first cartilaginous, verruculose, rarely squamulose, becoming above sulphureous-pulverulent. Scyphi dilated, very proliferous. Cylindrical podetia very rare.

A very common and very pretty species, growing on the ground on heaths and hills in lowland and subalpine districts. It is more familiar under its old names, *C. coccifera* and *C. cornucopioides*. Its bright vermilion-red tubercles generally spring from the diaphragm of the scyphi. Its spermogones resemble those of *C. alcicornis* and *C. rangiferina* in their internal structure; but, in form, colour, and consistence, they are not unlike the perithecia of certain Sphærias; they are seated on the margins of the scyphi. This is probably the "Red Cup-moss" of which Mrs. Hemans sings in the following stanza:—

> "Oh! green is the turf where my brothers play
> Through the long bright hours of the summer day;
> They find the *red cup-moss* where they climb,
> And they chase the bee o'er the scented thyme."

It occurs in the Antarctic regions, and is otherwise somewhat widely distributed. It appears to contain a small quantity of gummy and starchy matter; hence it has been used, boiled in milk or syrup, in hooping-cough and other chest affections in children. In Thuringia a decoction has been used in the treatment of intermittent fevers.

2. CLADONIA DEFORMIS (*deformis*, misshapen) is a large, strong, coarse form, irregular in shape, rarely fertile, occurring commonly on peaty ground and rotten wood in many highland districts. It occurs also in the Arctic and Antarctic regions. The scyphiferous podetia are elongate-turbinate or tubæform; the cylindrical ones often ventricose or lacerate-fissured. (E. B. 1394.)

3. CLADONIA BELLIDIFLORA (*bellus*, beautiful, and *flos*, a flower). Podetia always cartilaginous, verruculose, squamulose, slender or strong. Scyphi small, narrow, rarely proliferous. Cylindrical podetia usually simple. Apothecia often conglomerate or polycephalous.

A common and beautiful species, growing on moist rocks and on ground on many of our Highland mountains, as Ben Nevis, Ben Lawers, Ben Lomond, and also on hills of minor elevation, as the Cheviots and Pentlands. Its beautiful scarlet apothecia render this one of the most handsome of British Lichens. Steeping in water, we have found, destroys the bright scarlet colour, however, changing it to a dull brown; this the student ought to bear in mind when he is preserving specimens for the herbarium.

†† *Apothecia brown.*

|| *Scyphiferous podetia simple. Thallus normally persistent.*

4. CLADONIA PYXIDATA (*pyxis*, a cup or box). Podetia

granulate-pulverulent, from greenish becoming greyish; scyphiferous ones turbinate, commonly proliferous; cylindrical rare, slender, simple; thalline squamules thin, elongate-lacinulate.

A very common Lichen, growing on the ground, on the mud of old walls, on rotten wood, and on heaths in lowland and subalpine districts. Its geographical range is wide, occurring in the Arctic regions, America as far south as the Straits of Magellan, Australia, and other countries; on Orizabo it was found at an elevation of 14,600 feet. It is the "Cup Moss" of the London herbalist. It contains a considerable amount of gummy or starchy matter, and has been much used as a demulcent in various chest affections, as hooping-cough. Its medicinal uses, which have been most varied, have resembled those of *Cetraria Islandica.**

5. CLADONIA ALCICORNIS (*alces*, the elk, and *cornu*, a horn) is distinguished by its cæspitose, subfoliaceous, macrophylline thallus, which is elongate-laciniate, subpalmate, prostrate, when dry pale greenish above; lacinulæ linear; margins, beneath, sometimes subpilose.

Not very common, and usually sterile. In this and the

* Dillenius, Dissertatio de Lichene Pyxidato, 1785 (in Schlegel's 'Thesaurus Materiæ Medicæ,' vol. i.) : Willis, Pharmaceuticæ rationalis, Part II.

following species the horizontal or primary thallus is generally alone met with, the podetia being comparatively rare. Spermogones may frequently be discovered towards the margins, and on the upper surface of the thalline lacinulæ, as spherical, sessile or substipitate, at first brownish, afterwards blackish, bodies, with an almost invisible pore. Their cavity is simple; their sterigmata very fine, short, ramose filaments; their spermatia curved, cylindrical, and of extreme tenuity.*

6. CLADONIA CERVICORNIS (*cervus*, a stag) is a similar form, in which however the horizontal thallus is erectish, laciniate-lobate, and greyish-green above; the lacinulæ broadish. (E. B. 2574.) By some authors it is regarded as a macrophylline state of the next species.

||| *Scyphiferous podetia fruticulose-ramose; thallus normally evanescent.*

7. CLADONIA GRACILIS (*gracilis*, slender or elegant). Podetia cartilaginous, aphyllous or squamulose, glaucous or brownish-green. Scyphiferous podetia elongate-tubæform; scyphi regular, very proliferous. Cylindrical podetia simple or ramose, subulate or beaked.

A common species, growing on the ground, on heaths, and among moss in hilly and alpine districts. It also oc-

* Itzigsohn, 'Botanische Zeitung,' vol. viii., 1850.

curs in the Arctic and Antarctic regions, and is otherwise widely distributed.

** *Turbinate podetia openly infundibuliform; cylindrical ones entire.*

8. CLADONIA SQUAMOSA (*squama*, a scale). Podetia glaucous-granulose or squamulose. Infundibuliferous ones elongate-turbinate; infundibula denticulate-radiate, commonly very proliferous. Cylindrical podetia rarely subulate, usually symphycarpeous or cymose.—There are several varieties depending chiefly on the size and character of the thalline squamules, which are sometimes very small and narrowly lacinulate, and on the podetia being naked or roughened by decortication or growths, simple or divided. (E. B. 2362, var. *microphylla*; 2052, var. *parasitica*; 1796, var. *fungiformis*; 1782, var. *leptophylla*.)

Not uncommon, in some of its varieties, on the ground, and on putrid wood, in lowland and subalpine forests.

*** *Turbinate podetia obscurely infundibuliform; cylindrical ones closed, or gaping at the axils of the ramules.*

9. CLADONIA STELLATA (*stella*, a star). Podetia cartilaginous, always aphyllous, straw-coloured, extremities brownish; sterile extremities of turbinate ones stellately patent, fertile cymose, usually proliferous; cylindrical podetia simple

or ramose, bifurcate, axils seldom gaping, fertile ones digitately divided.

The var. *uncialis*, which is slender, rigid, subimperforate, with stellulate or bifurcate extremities, is common on the ground among moss on hill-heaths in lowland and alpine districts. We have frequently observed the base of the podetia in this variety, especially in large specimens from northern countries, of a beautiful blood-red tinge, as is the case in *Cetraria nivalis* and other Cetrarias. A similar discoloration sometimes exists in other ochroleucous Cladonias.

10. CLADONIA FURCATA (*furca*, a fork). Podetia aphyllous or squamulose, glaucous or brownish-green. Cylindrical ones fruticulose, subdichotomously ramose: axils and fertile extremities subperforate; fertile subcorymbose; sterile subulate, bifurcate. Thallus minute, crisped-lacinulate, rarely conspicuous.

Common on ground, among moss, on heaths, and in woods in lowland and subalpine regions.

11. CLADONIA RANGIFERINA (*Cervus rangifer*, the reindeer). Podetia very slightly farinose, at length verruculose, always aphyllous, greyish, fruticulose and very ramose, all cylindrical, subperforate at axils; extreme ramules radiate; fertile erect, cymose; sterile nodding. It may be known

from all the varieties of the preceding species, with which it is apt to be confounded, by the podetia never being polished and squamulose, but always slightly farinose and aphyllous.

It varies much in size,—being seldom taller than three or four inches in Britain,—and also in rigidity and strength; it is sometimes straw-coloured or ochroleucous,—and loosely ramose, or the terminal ramules are very ramose, entangled, and crowded.

A very common species on our hills and heaths in low-land, subalpine, and alpine districts, growing on the ground. On hills of minor elevation, round Perth and Edinburgh, it is abundant. Crabbe calls it truly—

"The wiry moss that whitens all the hill."

"Omnium lichenum copiosissima" according to Fries,—it is almost a cosmopolite; but its geographical range is, in various parts of the world, very irregular and limited. In northern Europe it is used like *Cetraria Islandica*, as a nutrient and demulcent. It is a social plant, covering in Lapland vast tracts of country, and growing to a height of six to twelve inches. The barren plains so covered are the favourite and only pastures of the reindeer during winter; the animals clear away the snow by means of their horns to

browse on the Lichen.* It is also frequently collected like hay as fodder for cattle during winter, and for the reindeer on journeys. Parry in the narrative of his Fourth Voyage mentions his officers collecting supplies of this Lichen as provender for the reindeer, which he used in the capacity of horses; he adds, it "required a great deal of picking" to separate it from the moss among which it usually grows. The daily quantity of cleaned "Reindeer Moss"—as it is popularly denominated—necessary for each animal on a journey he estimates at four pounds; but, he remarks, it can easily remain for five or six days without food. To prepare it as fodder for cattle, in some northern countries, hot water is poured over it; it is then mixed with straw, and a little salt sprinkled over the mixture. Cattle so fed are said to produce delicious milk and butter, while their flesh becomes fat and sweet. Bucke, in his 'Harmonies of Nature,' speaks of small cows, by feeding on this Lichen, whose milk becomes wholly cream. The stag, deer, roebuck, and other wild animals also feed on it abundantly during winter. But it is not only serviceable as food to the lower animals,—man himself is frequently compelled to use it in times of scarcity. It is sometimes powdered, mixed with flour, and

* *Vide* Linnæus, 'Flora Lapponica,' p. 332.

baked into bread; or it is boiled in milk or broth. Clarke, in his Travels, mentions having eaten it, and even speaks of it in a commendatory way. It is sold by the London herbalists for the purposes of the bird-stuffer. In a pulverized state it at one time formed a frequent ingredient in hair-powders and perfumes. This species has no distinct cortical layer; its podetia or ramules are hollow tubes, whose walls consist of a cartilaginous membrane composed of two layers of filamentous tissue. The internal layer is dense, horny, and whitish, and consists of solid, simple, parallel filaments closely united. The external layer is much thinner, and is composed of a somewhat lax felted network of equally solid, ramose, interlacing filaments, mixed here and there with groups of gonidia, so scattered as to communicate only a pale green colour. Its spermogones are the blackish apices of the nodding extremities of the sterile ramules. They are usually grouped, two to five frequently occurring together; they form tub-shaped bodies having a simple cavity. Their spermatia are cylindrical, curved, very abundant, and in water exhibit a vivid Brownian movement.

**** *Podetia papillæform or nodulose, devoid of scyphi or infundibula.*

12. Cladonia Papillaria (*papilla*, the nipple). Podetia

glabrous, glaucous or straw-coloured, extremities brownish; at first papillar, then clavate or cylindrical, at length when fertile fastigiate-ramose. Thallus microphylline. Apothecia reddish-brown, mostly symphycarpeous. It is an alpine and subalpine species growing on heaths on some of our Highland mountains, as Ben-mac-dhui; but it is rare in this country. It most generally occurs in an abnormal state, having short, vesicular, ventricose or gibbous podetia, bearing abortive apothecia. This species was formerly made the basis of a separate genus, *Pycnothelia*.

Nat. Ord. XII. *COLLEMACEÆ.*

Genus I. COLLEMA, *Hill.*

Gen. Char. Thallus foliaceous or filamentous; when moist flaccid, turgescent or pulpose-gelatinous (from the gluey matter which it contains abundantly); when dry membranaceous, coriaceous or coriaceous-cartilaginous. Apothecium discoid, scutellate or patellæform, sessile, rarely stipitate, brownish. (Name from κόλλα, gluten or gelatine; in allusion to the property possessed by the thallus of swelling into a gelatinous mass in water. Hence the Collemas are popularly designated the "Gelatinous" or "Jelly-Lichens.")

A comparatively small, but peculiar family, distinguished from all other Lichens by their vegetative system. The fructification resembles chiefly that of the Gymnocarpi; but, in some species, it appears to be truly angiocarpous. Hence the genus *Collema* may be appropriately considered intermediately between the Gymnocarpi and Angiocarpi. While the reproductive system is distinctly lichenoid, the vegetative system is somewhat algoid: on this account the Collemas have been regarded by many authors as abnormal Algæ, growing in the air, or as aquatic, algoid Lichens. Their vegetative system does not exhibit the ordinary divisions into three distinct layers or tissues, which are here generally confused and modified. What corresponds to the medullary tissue of other Lichens consists of a loose network of interlacing moniliform or beaded filaments,—formed by the apposition in linear series of minute globular cells,—and of delicate, narrow, branching tubes. In many species this tissue constitutes the bulk of the thallus. There is no distinct gonidic layer; the gonidia are represented either by green globules, frequently arranged in rows, but not united to each other, and interspersed among the meshes of the filamentous tissue,—or in some species, by chlorophyll dissolved in the mucilage of the thallus. In a few there is a cortical layer composed of

polyhedral cellules intimately united; in others there is no distinct epidermic layer, the plant consisting wholly of the filaments, tubes, and green granules above mentioned. In the latter case, the structure of the thallus so closely resembles that of the common *Nostoc*, that the Collemas and Nostoc have frequently been classed together, either among the Algæ or Lichens, according to different views on their morphology.* But *Nostoc* consists wholly of moniliform filaments embedded in a mucilaginous basis, never possessing the continuous tubes described as occurring in the Collemas. In rudimentary Collemas the individual cells or articulations of the moniliform filaments develope tubes which ramify and become interlaced, as in the hypothallus of other Lichens. The thallus varies considerably in ordinary physical characters. In some species it is very thin, and when moistened becomes pellucid or somewhat diaphanous, having a uniform and beautiful dark-green colour; in this case the thallus

* For observations on the relation of *Collema* to *Nostoc* and on the development and minute anatomy of various species of *Collema*, *vide* 'Botanische Zeitung,' July 24, 1854; Julius Sachs, January 5, 1855: also Bernhardi, 'Illustratio Lichenum Gelatinosorum,' in Schrader's 'Journal für die Botanik,' vol. i. 1799: Cassini and Duchesne, 'Bulletin de la Soc. Philomath,' 1817, or 'Journal de Physique,' 1817: Fée, 'Mém. de la Soc. du Mus. d'Hist. Nat. de Strasbourg,' vol. ii. 1835.

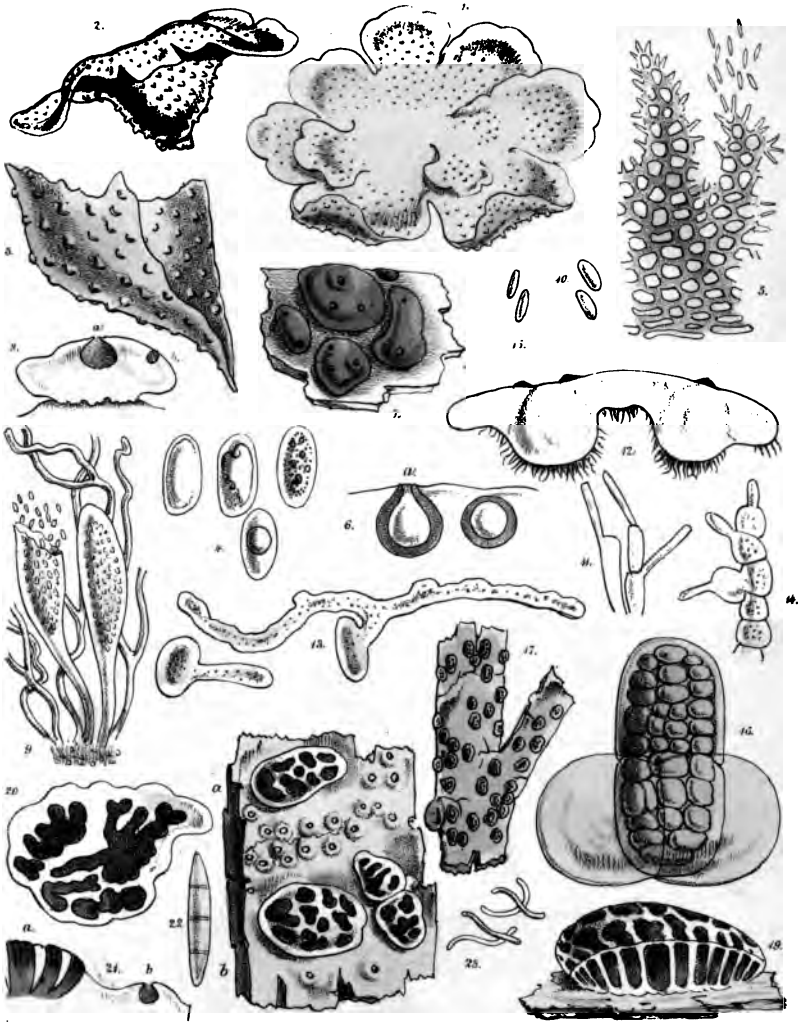
resembles the frond of many chlorospermous seaweeds, and here the chlorophyll, which in most Lichens is confined to the gonidia, is diffused through, or dissolved in, the thalline mucilage. Other Collemas have a thallus of a leathery or cartilaginous consistence, more resembling the normal or typical Lichen-thallus in structure. In some species the thallus is naked; in others, granulose or furfuraceous; and in a few, papulose or marked on the surface by pellucid papules or vesicles, which Schærer regards as in some way subserving, like the gonidia, the function of reproduction. The apothecium is usually developed in a thalline wart, and is at first globose, becoming gradually expanded, open, and discoid. In species having a thick and dense thallus it is generally scutellate, having a distinct thalline exciple; but in other cases this exciple is very thin, pellucid, evanescent, or it is covered by the thalamium, which becomes flattened and then convex (patellæform). In a few a proper exciple has been described, in which case the apothecium is patellate.

* *Thallus filamentous; apothecia patellæform.*

1. COLLEMA PUBESCENS (*pubesco*, to become mossy or downy). Thallus black, decumbent. Filaments capillaceous, terete-elongate, somewhat simple, entangled or loosely inter-

woven, softish. Apothecium black,—at first immersed in fusiform or ovoid, sub-apical swellings of the thalline filaments, and resembling in structure the apothecium of *Lichina*. (E. B. 2318.)

Not uncommon on alpine rocks on many of our Highland mountains, growing frequently along with varieties *tristis* and *lanata* of *Parmelia Fahlunensis*, with which it was classed by older writers in the genus *Cornicularia*. It is often found in small cavities in the rock which are occasionally filled with rain-water. The synonymy of this species has varied much, and it has long sought a resting-place in classification. Several authors have claimed it as an Alga; while according to others it has been by turns the *Lichen pubescens*, *Cornicularia pubescens*, *Ephebe pubescens*, and *Collema pubescens*. The thecæ are clavate; the spores elliptic, hyaline, and bilocular. The latter resemble, in their development, the spores of the genus *Lichina*. Its spermogones are to be looked for in minute spheroidal swellings towards the apex of the thalline filaments. The sterigmata are minute, simple, linear, and closely aggregated; the spermatia acrogenous, oblong, with truncate extremities. Bornet describes spermogones as occurring on one plant, and apothecia on another; if this be uniformly the case, it must be



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W.L.Lindsay del. Etch.lith.

Thomas Brown



regarded as a dicœcious species.* Indeed in the speculative but laborious dissertation of Bayrhoffer ('Einiges über Lichenen und deren Befruchtung,' Berne, 1851) Lichens are described as normally monœcious and dicœcious.

** *Thallus foliaceous, when dry membranaceous, when moist flaccid; apothecia patellæform and scutellate.*

2. COLLEMA ATRO-CÆRULEUM. Thallus very thin and somewhat diaphanous, lacerate-laciniate, reticulate-lacunose, from lead-coloured becoming reddish, when moist olive-coloured. Apothecia patellæform, minute, superficial, pale brown. The laciniæ vary in size, being sometimes narrow and imbricately arranged; in the most common variety, var. *lacerum*, they are broadish, sinuate, with dentate-ciliate margins.

Creeping over moss, and also growing sometimes on trees, rocks, and the ground in various Highland districts. This is one of the species possessing a distinct cortical layer, composed of intimately united, polyhedral cellules, while the medullary tissue resembles the filamentous texture of the

* For minute anatomy and synonymy, *vide* Bornet, 'Annales des Sciences Naturelles,' vol. xviii. 1852, p. 155: Berkeley, in Annals of Nat. Hist. 1851: Flotow, Bot. Zeitung, 1850, and 'Linnæa,' 1850: Davies, on *L. scaber* and some of its allies, in Trans. Linn. Soc. London, 1815.

more gelatinous Collemas. Its spores are ellipsoid, acuminate at the ends, having a delicate wall, and containing several transverse rows of cellules separated by indistinct and sometimes unsymmetrical septa.

3. COLLEMA CORNICULATUM (*corniculum*, a little horn), which resembles the preceding, but has convolute, bifid or trifid laciniæ, obtuse, with entire margins, is of peculiar interest as possessing, according to Tulasne, an angiocarpous fructification. Its apothecia he describes as small tubercles, perforated at the apex, grouped in large numbers. The thecæ and paraphyses are arranged as in *Endocarpon*, and the spores are ovoid and acuminate at the ends. Its spermogones are difficult of detection; they occur as minute, grouped punctuations towards the extremities of the thalline laciniæ, while the apothecia occupy the opposite ends or base. Under the microscope they appear like little transparent perithecia nestling under the epidermic or cortical layer of the thallus. The spermatia are linear, straight, and very minute. (E. B. 1635.)

4. COLLEMA RUPESTRE. Thallus lobate, plicate-undulate, macro- or micro-phylline, blackish-green; the lobes entire or crenate. Apothecia scutellate, flattish, scattered, dark brown. The lobes are decumbent or ascending, often im-

bricately arranged or closely crowded, sometimes granulose on both surfaces. The apothecia are sometimes largish, turgid, and conglomerate. (E. B. 1757, var. *furvum*; 1162, var. *fasciculare*.)

Not uncommon on rocks and stones, and sometimes on trees, in Highland districts.

**** Thallus foliaceous, when dry membranaceous, when moist pulpose-gelatinous; apothecia scutellate.*

5. COLLEMA GRANOSUM (*granosus*, granular or roughened by small grains). Thallus irregularly laciniate, from glaucous becoming blackish-green. Apothecia superficial, innate or sessile, reddish. In its chief varieties the laciniæ are elongated, lacerate-pinnatifid, or variously incised at the margins. (E. B. 2704, var. *ceranoides*; 2716, var. *dermatinum*.)

On calcareous stones among moss in shady places, but not very common.

***** Thallus foliaceous, when dry coriaceous, when moist turgescent; apothecia scutellate.*

6. COLLEMA MULTIFIDUM (*multus*, many, and *findo*, to slit or divide). Thallus laciniate, closely adnate, blackish-green. Laciniæ elongate, narrow, radiate, imbricate-lobate;

margins crisped; extremities cut. Apothecia superficial and marginal, largish, brown. The laciniæ may be concave or canaliculate; they are sometimes lacerate-pinnatifid or their margin is entire.

On rocks or stones in various parts of the Highlands. Its spermogones are immersed, but indicate their presence by small dark points on the surface of the thallus (as observed in var. *jacobæfolium*, which is distinguished by lacerate-pinnatifid laciniæ); but they are apt to be confounded with a parasitic *Sphæria*, whose perithecia are sometimes similarly immersed. The paraphyses of the same variety adhere intimately by their apices, which are much dilated; this is also noticed in other species of *Collema*.

7. Collema Burgesii. Thallus laciniate-lobate, loosely adnate, lead-coloured, smoothish,—below slightly tomentose. Lobes imbricate, minutely dentate-lacerate. Apothecia depressed, concave, large, brown, with an elevated lacerate-dentate or foliose margin. (E. B. 300.)

So named from having been first discovered by Dr. Burgess on the hazel and birch in Dumfriesshire. It occurs on trees in various parts of the Highlands, as about Loch Lomond, Inverary, and Glencoe. Its spores resemble those of *Urceolaria scruposa*; the contained cellules are arranged in

cross rows, and sometimes appear divided also into two vertical series. Moniliform filaments, of which the bulk of the thallus is composed, are here easily studied.

***** *Thallus foliaceous, when dry coriaceous-cartilaginous, when moist pulpose-gelatinous; apothecia scutellate, rarely patellate.*

8. COLLEMA PLICATILE (*plica*, a fold or plait). Thallus blackish-green, laciniate, orbicular, laciniæ undulate-plicate, —centre imbricate-lobate. Apothecia superficial, sessile, reddish. (E. B. 2348.)

On rocks in some parts of the Highlands.

The genus *Lichina* is classed by some Lichenologists among the *Collemaceæ*. We allude to it here merely for the purpose of claiming, as a true Lichen, a genus which has long been a truant among the ranks of the Algæ. As a seaweed it has been described in a companion volume (Dr. Landsborough's 'Popular History of British Seaweeds,' 2nd edition, p. 100). I shall therefore only point out a few of its structural characters, which justify its separation from the Algæ and reception among the Lichens. The two British species. *L. pygmæa* and *L. confinis* are more or less common on all our seaside rocks. Landsborough confesses frankly "these two little plants are introduced as interlo-

pers, without any regard to system." Dr. Greville, a very high authority, includes them in his 'Algæ Britannicæ,' but expressly states, "in regard to habit, the *Lichinæ* touch closely on the boundary of the Lichens." Harvey, in his classic work on British Algæ, however, excludes this genus, thereby distinctly implying his belief that it does not properly pertain to the Algæ. In the structure of the thallus, as well as in the characters of the apothecia and spermogones, the *Lichinæ* are decidedly lichenoid. In the characters of their apothecia and contents they resemble the genera *Calicium* and *Sphærophoron*. The fructification is angiocarpous; the spores are glued to each other in linear series, and assume their mature form only after dissociation and escape from the thecæ, but they do not accumulate on the surface of the thalamium as in these genera. The spermogones in *L. pygmæa* occur immediately below the spherical apothecia which terminate the thalline ramules; their ostioles are easily recognized, and their cavity is pluricellular. The spermatia are very minute and numerous, ovoid, and generated acrogenously from irregular cylindrical sterigmata. In *L. confinis* the spermogones are small ovoid bodies, seated on the extremities of the thalline ramuscules, and frequently implanted upon the apothecia themselves. The spermatia are

slightly more elongated and narrow than those of *L. pygmæa*.*

Section II. ANGIOCARPI.

In the species belonging to this section the apothecium is closed and globose, perforated by a pore or irregularly dehiscing, sessile or innate, having a thalline or proper exciple (perithecium), and a nucleiform thalamium, which is frequently pale-coloured or whitish, and waxy or gelatinous.

Nat. Ord. XIII. *SPHÆROPHORACEÆ, Fries.*

Fam. Char. Thallus vertical, shrubby. *Apothecia* terminal. *Exciple* formed of dilated extremity of thalline ramules, closed, at length irregularly lacerate-dehiscent. *Thalamium* subglobose, cleaving or separating with the thecæ. (Name from σφαῖρα and φορός, in allusion to their *bearing* a *spherical* fructification.)

Genus I. SPHÆROPHORON, *Ach.*

Gen. Char. Thallus having a crustaceous-cartilaginous cortical

* Montagne, Memoir on *Lichina*, in Annales des Sc. Nat., 2nd series, 1841, and in the 'Hist. Nat. des Canaries' of Mr. Webb, 1840: Fée, on *Lichina* and *Paulia*, 'Linnæa,' vol. x., 1836: Flotow, on *Lichina*, 'Linnæa,' vol. viii.: Decaisne, on *Lichina*, Bull. de l'Acad. Roy. des Sc. et Bell. Lettr. de Bruxelles, vol. vii. 1840.

layer, greyish, becoming brown; internally solid, white, stupose. Apothecium spherical, the bluish-black spores accumulating on the surface of the thalamium as a soot-like powder.* Thalamium internally floccose-cartilaginous.

1. SPHÆROPHORON CORALLOIDES. Thallus brownish, waxy, smoothish, terete or somewhat compressed; ultimate ramules having an obtuse, but not swollen, apex. Apothecia erect, globose; margin often inflexed. Spores roundish or oblong. The thallus is either loosely and irregularly branched or it is cæspitose, fastigiate, and dichotomously branched. (E. B. 115, var. *laxum*.)

Common on rocks in Highland districts. The blackish or indigo-coloured dust which covers the thalamium is found to consist, under the microscope, of the spores, mixed with a quantity of blackish or bluish-black granular *débris*. Leighton describes the spores as hyaline and double-walled, and ascribes their black colour and irregular granulated form to their contents, which are blackish or bluish-black granules, and which, when they escape, adhere to the exterior of the mother-cell. Tulasne speaks of the epispore as

* For observations on the structure of the Apothecia, *vide* Camille Montagne in 'Ann. des Sciences Naturelles,' vol. xv. p. 147, or 'Annals of Natural History,' vol. x. 267.

black and tuberculated, while the endospore is pale but thick; and the phenomena of germination prove the correctness of this view. In structure and development the thecæ and spores are similar to those of the genus *Calicium*. When full of nearly ripe spores the theca is a very beautiful object under the microscope, resembling a row of bluish-black beads supported on a narrow, tapering pedicle. The spermogones are similar in position and structure to those of the following species, but are seldom seen. The geographical range of this and the following species is very wide, occurring on rocks in the Arctic and Antarctic regions, and almost throughout temperate and tropical countries, with various exceptions or irregularities in local distribution.

2. SPHÆROPHORON COMPRESSUM (*comprimo*, to press together). Thallus greyish, frosted, having a somewhat rigid, coral-like character, compressed, irregularly branched, fibrillose,—ultimate ramules as if articulated and swollen at the apex. Apothecia obliquely placed, flattened or discoid, especially in old state, often with a reflexed margin. Spores round. (E. B. 114.)

Also somewhat common on the ground and on rocks in alpine districts. Its spermogones occur towards the terminations of the most delicate ramules; under the lens they

appear as small, black, superficial perithecia, pierced by a minute pore. The spermatia are linear, of great tenuity, straight, and very numerous. This species is much rarer in fructification than the preceding.

Nat. Ord. XIV. *ENDOCARPACEÆ, Fries.*

Fam. Char. Thallus foliaceous or crustaceous. *Apothecia* immersed, closed, having a regular, prominent ostiole. *Exciple* wholly thalline, sometimes modified; *thalamium* deliquescent.

Genus I. ENDOCARPON, *Hedw.*

Gen. Char. Thallus foliaceous or scaly, cartilaginous, subpeltate, sometimes adherent by a central point and umbilicate, or appressed and closely adnate by delicate fibres. Apothecia globular; exciple membranaceous, thin, pale; thalamium flesh-red, becoming black. (Name from ἔνδον, within, and καρπός, fruit, in allusion to the immersed apothecia.)

* *Thallus foliaceous, subpeltate.*

1. ENDOCARPON MINIATUM (*minium*, red lead or vermilion). Thallus coriaceous, umbilicate, lobed, or cæspitose and imbricate-lobate, when dry grey-pruinose above, becoming brown,—below smooth, tawny, or blackish. Ostioles mi-

nute, brownish-black. There are two marked varieties, var. *umbilicatum*, which is umbilicate, lobed, simple or polyphyllous; and var. *complicatum*, which is cæspitose and imbricate-lobate, with ascending lobes. (E. B. 593.)

Common in lowland and subalpine districts, on moist rocks in the neighbourhood of waterfalls or rivers, or which are frequently covered by water. We have found it, by the side of the Tay, on boulders frequently covered by the river when flooded, and on the craggy southern face of Kinnoull Hill, near Perth. When under water it has a deep olive-colour. It sometimes attains a diameter of several inches: we have seen large specimens from the island of Mull. Its spores are ellipsoid, double-walled (margined), pale. Its spermogones are immersed, and indicate their presence by circular, brown, flattened or centrally depressed spots towards the periphery of the thallus. They are ostiolate; they exceed in depth the thickness of the thallus, and thereby produce on its under surface, as the apothecia also do, a papulose roughness; and they consist of a very dense, grey or rose-coloured tissue. The sterigmata are articulated and ramose; the spermatia straight.

** *Thallus squamulose, adherent by whole surface.*

2. ENDOCARPON SMARAGDULUM (*smaragdus*, the emerald).

Thallus consists of a number of contiguous, orbicular or polygonal, minute, greenish scales.

Leighton has arranged under this species several varieties which belong doubtfully to the genus *Endocarpon*. The two commonest varieties, which occur on alpine rocks in various parts of Scotland and England, are classed by Schærer under *Lecanora cervina*, one of the squamulose Lecanoras. This seems to us a more appropriate position for these Lichens, whose fructification however is decidedly anomalous. They are distinguished by their spores being innumerable; we have hitherto found eight to be the average or maximum number in each theca. The spores are very small, oblong or linear-oblong, pale yellow, and exhibit a lively Brownian movement in water, which Leighton describes as a "very peculiar, quick, wriggling, spontaneous motion, as in a dance, setting and retiring one from the other in quick succession." He is in error however when he compares this movement to that of the zoospores of the Algæ, and attributes its causation, theoretically, to the presence of cilia. (E. B. 1512, var. *smaragdulum*; 2657, var. *rufescens*; 2152, var. *privigna*.)

Var. *Sinopicum* is remarkable for its brick-red colour, which is probably due to peroxide of iron taken up from the soil. (E. B. 1776.) Under the lens may be discovered

a series of depressed, brownish points, which are the contracted mouths of urceolate, immersed apothecia. The thecæ and paraphyses are chiefly developed from the base of the cavity. The latter are of capillary tenuity, straight, almost simple, and embedded in an abundant mucilage; the most central ones are united at the summit, which reaches that of the apothecia, and has a reddish-brown colour. Hence the occlusion of the apothecium is less perfect than in a typical species of the genus *Endocarpon*,—as *E. miniatum*, in which the paraphyses are developed perpendicularly to the walls and convergently to the centre of the cavity, and are colourless throughout. Its spermogones are denoted by blackish points similar to, but smaller than, those which mark the orifice of the apothecia. Their cavity is sinuous; their sterigmata linear and irregular; their spermatia straight.

**** Thallus squamulose or tartareous; spores very large.*

3. ENDOCARPON SOREDIATUM. Thallus a single squamule, closely adnate by delicate rhizinæ; margins greyish-pulverulent. Thecæ two-spored. Spores linear-oblong, obtusely rounded at ends, uniseptate, green, cellular or muriform. (E. B. 2612.) The only habitat mentioned by Leighton is Rottingdean Cliffs, Sussex; and by Hooker, mud walls at Thetford, Norfolk.

Genus II. SAGEDIA, *Fries.*

Gen. Char. Thallus subcrustaceous; apothecia immersed, globose, becoming attenuated at the apex into a narrow neck, opening by a dilated ostiole on the surface of the thallus.* (Name probably from σάγη, a peculiar kind of shield, and εἶδος, like, in allusion to the form of the fructification.)

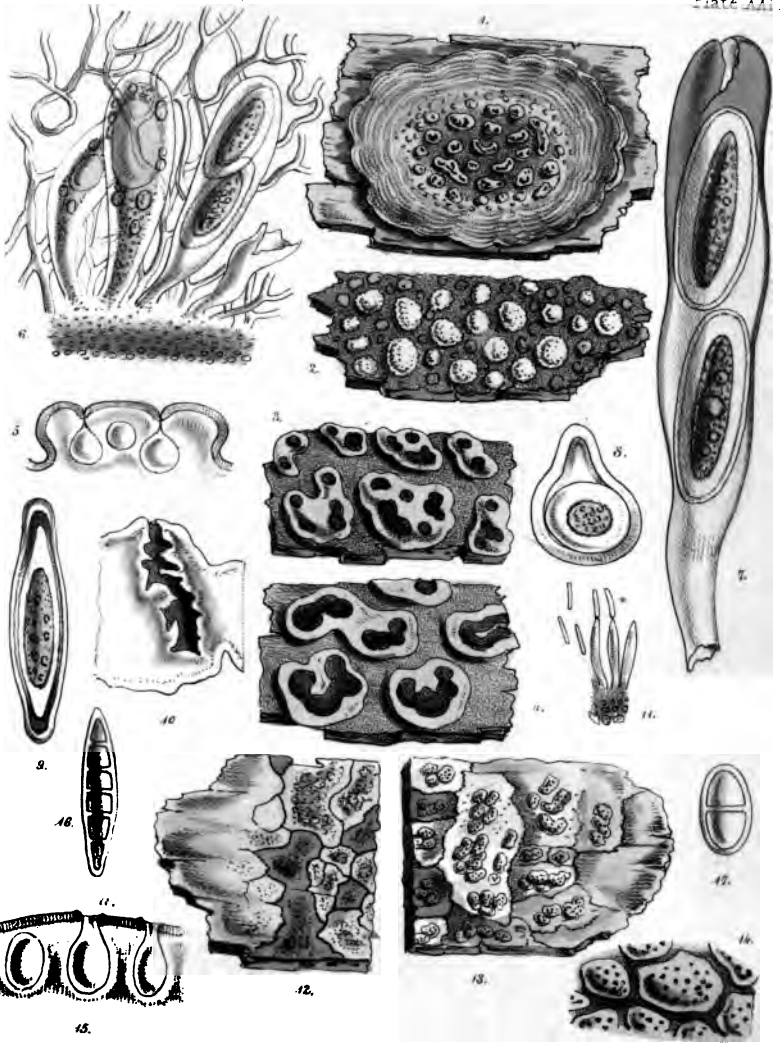
This genus is intermediate in characters between *Endocarpon* and *Verrucaria*. It agrees with the former in having an immersed apothecium, with a gelatinous deliquescent thalamium, but it differs in the necked ostiole; while it resembles the latter in the character of the thallus, but differs in having no carbonaceous perithecium, in its necked ostiole, and in the wholly immersed thalamium.

1. SAGEDIA CINEREA. Thallus membranaceous, squamulose, closely adnate,—above greyish-pruinose,—below blackish-spongy; squamules discrete, or aggregated into a contiguous crust somewhat foliaceous at circumference. Ostioles protuberant, spheroidal, black.

On the ground or rocks on the summit of Ben Lawers, Perthshire, and on the island of Stronsay, Orkney. Its spores are narrow-oblong, uniseptate, pale. (E. B. 2013).

2. SAGEDIA AGGREGATA (*aggrego*, to gather together).

* On *Sagedia*, Fr., and allied genera, 'Botanische Zeitung,' Feb. 23, 1855.



W. Wadsley del. Pitch lith

Francis Brooks sculp.



Thallus tartareous, smooth, cushioned, glaucous or greyish-olive, often traversed by black lines. Apothecia punctiform, crowded. Spores fusiform, elongate, five-septate, pale. (E. B. 1752.)

On the bark of trees, not uncommon in various parts of England.

Genus III. CHIODECTON, *Fée.*

Gen. Char. Thallus crustaceous; apothecia verrucæform, pulverulent; thalamia numerous, aggregated, immersed in thalline warts, waxy-gelatinous; ostioles subdisciform, prominent. In general characters it resembles the next genus. (Name from χιών, snow, in allusion to the pulverulescence of the apothecia; hence popularly called 'Snow-wort.')

1. CHIODECTON ALBIDUM (*albidus*, whitish). Thallus leprose, whitish, effuse. Apothecia tuberculiform, sessile, niveo-pulverulent, besprinkled with black points or ostioles. Spores elongate-fusiform, three-septate, pale yellow.

On shady rocks between Killarney and Dunkerron, county Kerry, Ireland. Its spermogones are to be carefully looked for with a lens on the white spots of the thallus, which indicate the position of rudimentary fructiferous tubercles, as isolated, black points, each of which corresponds to a glo-

bular, immersed utricle. The cavity is simple; the sterigmata linear and short; and the spermatia linear, of great tenuity, and curved into an arc. This species is interesting as the sole British representative of a genus which attains its maximum development in warm or tropical climates.

Genus IV. PERTUSARIA, *DC.*

Gen. Char. Thallus crustaceous or cartilaginous-membranaceous; apothecia verrucæform, normally covered by a cortical layer of thallus, enclosing one or several waxy-gelatinous thalamia, enveloped in pale, membranaceous, thalline exciples; ostioles depressed. (Name from *pertusus*, full of holes or cracked, in allusion to the appearance of the fructiferous warts.)

1. PERTUSARIA COMMUNIS (*communis*, common). Thallus glaucous or white, determinate, in young state zonate at periphery; apothecial warts subglobose, irregular, crowded, generally multi-locular, depressed round the punctiform, black ostioles; frequently sterile, sorediiferous, variolarioid, or isidioid. (E. B. 677.)

Very common on forest-trees, especially the beech, ash, and oak, in lowland districts. In some localities it is only found in a variolarioid state,—the whole thallus being covered

with a white, mealy powder, or with numerous, small, globular, white soredia. The apothecia are very frequently abortive and sorediiferous, the soredia being then usually scattered, large, distinctly circumscribed, globular, flattened or scutellate. We have met with all these forms—frequently combined also with isidioid conditions (E. B. 1511)—on trees in the neighbourhood of Perth, especially on the ash, towards the base of its trunk or on its exposed roots. The variolarioid states of this Lichen include several familiar species of the old genus *Variolaria* (E. B. 1713 and 1714). They are chiefly remarkable for the quantity of oxalate of lime which they contain; so much indeed, that they have been used in France as a source of oxalic acid. Hence some varieties taste intensely bitter; and hence also the foundation of their use as a febrifuge in intermittents. Under the microscope we have found large quantities of octahedral crystals, apparently of oxalate of lime, in some foreign variolarioid varieties of *P. communis* (the *Variolaria amara* and *V. faginea* of older writers), but not so abundantly as in *Urceolaria scruposa*. Braconnot found 29 per cent. of oxalic acid in combination with 18 of lime in *V. faginea*. The thecæ of *P. communis* are very large and strong; they are two-spored, thick-walled, linear or ribbon-shaped and much elon-

gated. They acquire a beautiful blue colour under the action of iodine, and, when empty, they become variously bent and twisted. The spores are the largest to be found in British Lichens; when isolated on a slip of glass they may almost be distinguished by the naked eye. They are ellipsoid or oval, elongate, unilocular, thick-walled. The epispore is very thick, especially towards its extremities, where it gives way during germination, allowing the protrusion of the bulging endospore; it is transparent, and consists of several layers of unequal thickness and density. It is moreover coated externally with a thick envelope of granular mucilage, which frequently gives it a roughened appearance; and this coating is apt to be mistaken for a true episporic layer. The endospore contains a quantity of granular matter of a yellowish or greenish tint, mixed frequently with large and numerous oil-globules. Between the epispore and endospore there is a considerable hyaline margin. The paraphyses are linear and of great length; along with the thecæ they are embedded in an abundant mucilage which swells greatly in water. The spermogones are difficult of discovery, and occur as scattered, minute, black punctuations; they are immersed, have a simple, narrow, sinuous cavity, and a pale-coloured envelope, which cannot readily be distinguished

from the surrounding tissues. The sterigmata are slender and straight filaments; the spermatia straight and acuminate at the extremities. In addition to the ordinary structural elements, the cavity of the spermogones contains a loose network of long ramose filaments embedded in a transparent mucilage.

Genus V. THELOTREMA, *Ach.*

Gen. Char. Thallus crustaceous-cartilaginous. Apothecia verrucæform; exciple thalline, at first closed; thalamium deeply sunk, ultimately collapsed, depressed, rigid, enveloped in a discrete, membranaceous, lacerate-dehiscent, interior exciple. (Name from θηλή, a wart, and τρῆμα, a perforation, in allusion to the form of the apothecium.)

1. THELOTREMA LEPADINUM (λεπάς, a limpet). Thallus membranaceous-cartilaginous, whitish, effuse. Exterior exciple of apothecium superficial, truncate-conical, with an entire margin,—internal one vaulted, with a lacerated margin, enclosing a blackish, at first greyish-pruinose thalamium, apothecia at length becoming urceolate-scutelliform. Spores large, fusiform, pale yellow, cellular. (E. B. 678.)

On the bark of trees in lowland and subalpine districts; not very common. Its thecæ are large and two or three-

spored; its spores resemble those of some Graphideæ and Urceolarias. The enclosed cellules in this and other cellular or muriform spores, are regarded by some authors as nucleiform hollows or cavities in a solid spore, which are occupied by a transparent, oily or granular protoplasm. The apothecia, on superficial examination, may be confounded with those of the genus *Urceolaria*.

2. THELOTREMA EXANTHEMATICUM. Thallus leprose, greyish or ochry; external exciple immersed by its base in the rock, plano-convex, protuberant, at first closed, becoming centrally radiate-fissured, and at length open,—internal exciple waxy, with a connivent margin, enclosing a yellow, discoid thalamium. Spores linear-oblong or lanceolate, tapering at ends, three-septate, pale yellow; their surface roughened by fine, distant points. (E. B. 1184.)

On calcareous rocks in lowland and subalpine districts, but rare; a very pretty but minute species. The apothecia bear some resemblance to those of the genus *Gyalecta*.

Nat. Ord. XV. *VERRUCARIACEÆ, Fries.*

Fam. Char. Thallus crustaceous. *Apothecium* rounded, fre-

quently hemispherical or globose, its base more or less immersed in thallus. *Perithecium* (proper exciple) closed, generally carbonaceous, ostiolate, never necked. *Thalamium* gelatinous, subhyalline, diffluent.

The members of this family from their appearance are called 'Wartworts' (*verruca*, a wart), and are besprinkled over the surface of rocks or the bark of trees as small, black or dark-coloured, globular warts.*

Genus I. SEGESTRELLA, *Fries.*

Gen. Char. Perithecium solitary, waxy-membranaceous, coloured (reddish or brownish); ostiole simple, subpapillate.

1. SEGESTRELLA THELOSTOMA. Thallus subtartareous, pale greyish-brown, contiguous, effuse. Apothecia largish, reddish-brown, apex alone projecting from the conical, thalline tubercles. Spores ellipsoid, margined, pale yellow. (E. B. 2153.)

On quartzose shady rocks in lowland and subalpine regions, but rare: a somewhat anomalous and doubtfully distinct genus and species.

* Duby, Botanicon Gall., vol. ii.: Flotow, Bot. Zeitung, vol. viii., 1850: Flörke, Magaz. f. d. Neuest. Entdeck. in d. Naturk., 1807.

Genus II. VERRUCARIA, *Pers.*

Gen. Char. Perithecia solitary, horny-carbonaceous, black; ostiole simple, papillæform or perforated.

* *Corticolous species.*

† *Perithecium entire.*

1. VERRUCARIA NITIDA (*niteo*, to look bright or shining). Thallus membranaceous-cartilaginous, contiguous, determinate, olive-coloured, shining. Apothecia largish, but varying in size; base innate in hemispherico-concoid, thalline tubercles; ostioles papillate, at length pertuse. Spores ellipsoid or oblong, somewhat large, three-septate, reddish-brown; each loculament contains a peculiar rhomboid cellule, which gives the spores a very peculiar appearance. (E. B. 2607.)

On the smooth bark of various forest-trees, as the beech and ash, in lowland districts. Its spermogones are marginal, situated along or parallel to the black sinuous lines which denote the boundaries of each individual thallus; they are depressed, blackish, and about the size of the ostioles of the apothecia. The sterigmata are linear, short, and nearly as slender as the spermatia, which are linear, curved, and very numerous.

†† *Perithecium dimidiate.*

2. VERRUCARIA EPIDERMIDIS (*epidermis*, the cuticle or

bark of a tree). Thallus leprose, whitish or greyish, very thin, contiguous, effuse. Apothecia small, elliptic-conoid, plano-depressed, spreading at the base; ostioles papillate, entire or pertuse. Spores of medium size, somewhat resemble the figure 8; epispore hyaline; endospores pale yellow. (E. B. 1848, var. *analepta*.)

On the bark of the oak, birch, and other forest-trees in lowland regions. The thallus is so thin as to appear absent, the perithecia seeming to rise directly from the bark, upon which the plant grows. The bilocular spores appear formed of two oboval cellules in apposition at their broadest extremities. The epispore seems to be for some time coated with a transparent mucus, which disappears as the spore reaches maturity. The black, point-like spermogones are scattered among the apothecia; their spermatia resemble those of *Pertusaria communis*. In most Verrucarias the spermogones are abundant, and resemble in appearance the perithecia, from which they are distinguished by their inferior size. In some Verrucarias, and various other Lichens, spermatia and spores have been observed to occur within the same receptacle.

3. VERRUCARIA GEMMATA (*gemmo*, to bud). Thallus somewhat thick. Apothecia conical, large, innate at base;

ostioles papillate, at length pertuse. Spores broadly oblong, uniseptate, pale. (E. B. 2617.)

On the trunks of old forest-trees in lowland regions. Its somewhat thick, whitish, continuous thallus appears to contain a distinct gonidic layer, a circumstance very unusual among the Verrucarias, whose vegetative system is more generally represented by loosely interwoven filaments and scattered gonidia innate in the bark on which they are developed. Its thecæ are long and linear, and its spores arranged in a single, linear series, as in *Calicium* and *Sphærophoron*. The spermogones are black, scattered, and prominent, the sterigmata delicate; and the spermatia acrogenous, and of great tenuity.

** *Saxicolous species.*

† *Perithecium entire.*

4. VERRUCARIA MURALIS. Thallus tartareous-farinose, whitish or greyish, effuse, evanescent. Apothecia subglobose, minute, immersed, becoming emergent, pruinose, then naked; ostioles papillate, pertuse. Spores linear-oblong, uniseptate, cellular, greenish-yellow. (E. B. 2647.)

On calcareous stones and on the mortar of walls, but not common.

†† *Perithecium dimidiate.*

§ *Perithecium incurved at base.*

¶ *Inner tunic (or exciple) black.*

5. VERRUCARIA TRACHONA (τραχύς, rough). An Irish species (from Kerry), having fusiform, three-septate, pale yellow spores.

¶¶ *Inner tunic pale, not black.*

6. VERRUCARIA BORRERI. A species growing generally on calcareous stones, having large, broadly oblong, uniseptate, granulate, pale spores. (E. B. 2791.) So named in honour of Mr. Borrer of Henfield, Sussex, one of the most distinguished British Lichenologists.

§§ *Perithecium neither incurved nor spreading at the base.*

¶ *Inner tunic black.*

7. VERRUCARIA UMBRINA. Thallus thin, uniform, very minutely cracked, at first olive, becoming dark umber-coloured or blackish, forming ink-like stains on stones (especially granitic) about fresh-water lakes and streams. Apothecia numerous, minute, crowded, prominent, conoid, black, somewhat shining. Spores oblong, margined, pale. (E. B. 1499.)

Its habit resembles that of *V. maura*, a maritime and very common species.

¶¶ *Inner tunic pale.*

8. VERRUCARIA MUTABILIS (*mutabilis*, changeable). Thallus umber-coloured. Apothecia minute, scattered, numerous, round, sometimes shining. Spores oblong, pale, small. (E. B. 1712.)

Sometimes forms orbicular, or dendritic-effigurate patches on stones in shady places.

§§§ *Perithecium spreading at base.*

¶ *Inner tunic black.*

9. VERRUCARIA MAURA (*Maurus*, a Moor). Thallus thick, dark reddish-black, coarsely cracked, smooth, shining, papillose, effuse. Apothecia scattered, largish, hemispherical, wholly immersed, thalline papillæ which cover them marked by a large, distinct pore. Spores oblong, double-walled, pale. (E. B. 2456.)

Common on rocks and cliffs on various parts of the east coast of Scotland, as about Dunbar.

¶¶ *Inner tunic pale.*

10. VERRUCARIA MARGACEA. Thallus greyish-brown or greenish, contiguous or slightly rimulose, forming orbicular, determinate maculæ, or effuse. Apothecia partially projecting from small, conical, thalline papillæ; expanded base of perithecium visible through the thin thallus (this base re-

mains as a black ring in old state,—prominent part of apothecia falling away). Spores linear, rounded at the ends, three-septate, brown. (E. B. 2768.)

*** *Terricolous species.*

11. VERRUCARIA EPIGÆA (ἐπί, upon, and γῆ, the earth). Thallus filmy or leprose, pale greenish. Apothecia spherical, small, half-immersed; ostiole pertuse. Spores irregularly obovate, hyaline. (E. B. 1681.)

On argillaceous soil in lowland woods.—Its apothecia somewhat resemble those of the genus *Sagedia*.

Nat. Ord. XVI. *LIMBORIACEÆ, Fries.*

Fam. Char. *Thallus* crustaceous. *Apothecium* round; *perithecium* carbonaceous, closed, variously dehiscent. *Thalamium* waxy, becoming rigid.

Genus I. PYRENOTHEA, *Fries.*

Gen. Char. Thalamium globular, becoming protruded from the exciple, falling to pieces; perithecium becoming explanate and empty. Spores free (not contained in thecæ), agglutinated, becoming disunited or dissolving on the application of moisture, and frequently issuing from the perithecial pore in a continuous stream or cloud (as in the Fungi).*

* Von Flotow, in 'Botanische Zeitung,' 1850: Berkeley and Broome,

1. PYRENOTHEA LEUCOCEPHALA (λευκός, white, and κεφαλή, the head). Thallus glaucous or whitish, leprose, warted with tubercles of the same colour or whiter; exciple whitish-pulverulent; thalamium covered with a pale brick-coloured dust, at length naked. Spores innumerable, irregular, gibbous, linear-oblong, pale yellow. (E. B. 2642.)

On fir and other trees in lowland woods. Its spermogones are prominent, black, obtuse, at first whitish-pulverulent; the spermatia are numerous, straight, and linear. The fructification is rare.

Genus II. STRIGULA, *Fries*.

Gen. Char. Thallus generally developed below the epidermis of coriaceous perennial leaves, on which the plant is parasitic. Perithecia subglobose, collapsing, opening at length by a pore or fissure. Thalamium gelatinous, becoming rigid, black, and cracking on exposure.

1. STRIGULA BABINGTONII. A species growing on the leaves of the Box and Laurel in various parts of England,—having subcymbiform, three-septate spores. Named after

' Hooker's Journ. of Bot. and Kew Garden Miscellany,' vol. iii., 1851 : Tulasne, ' Comptes rendus de l'Acad. des Sc.,' March 31, 1851.

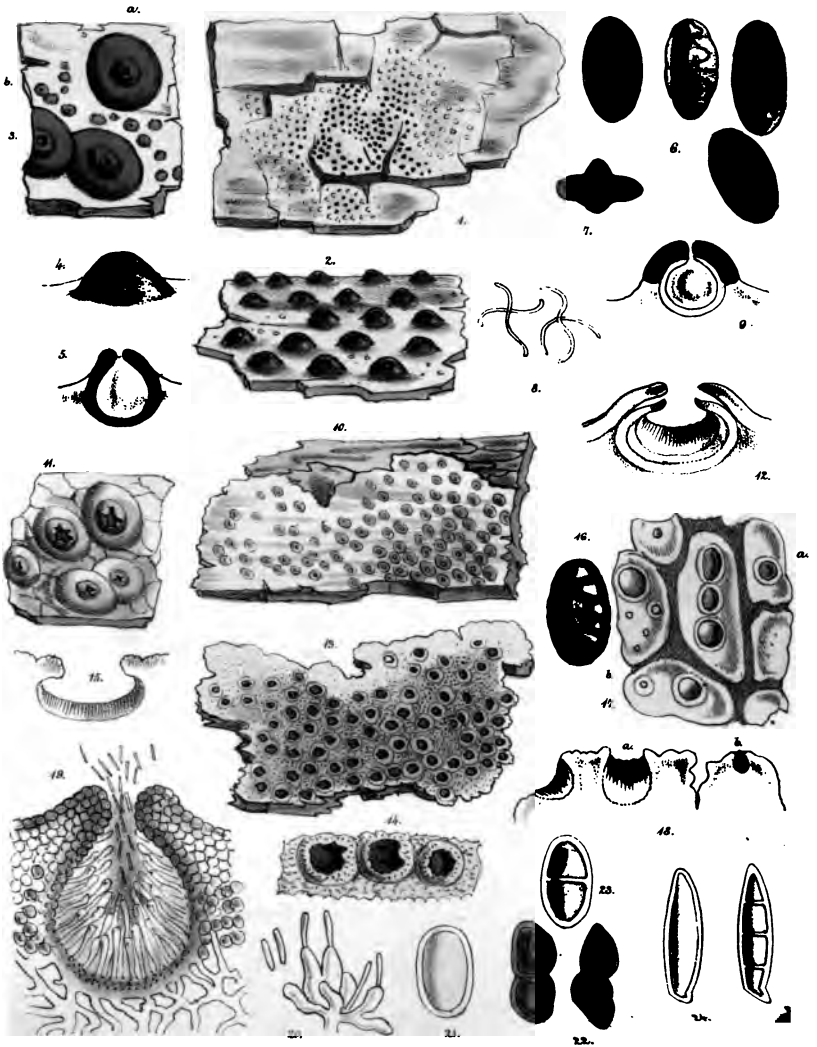
the Rev. Churchill Babington, of Cambridge, a gentleman who has done much to elucidate the Lichenology of Britain and other countries. (E. B. 2957.)

We are doubtful of the propriety of admitting the Natural Order *Limboriaceæ* among the Lichens: the characters of the fructification are very anomalous, but appear more fungoid than lichenoid. The deliquescent thalamium, the naked spores, and their mode of ejectment from the perithecium, in the genus *Pyrenothea*, are quite exceptional among Lichens, although common among Fungi.*

Before closing our description of typical British species, we would briefly allude to several genera of very minute or microscopic, athalline, parasitic Lichens,—some of which are interesting from their possessing pycnides and stylospores in addition to the reproductive organs common to other Lichens,—and which have recently been fully described for the first time by Tulasne. Some of them have long been fa-

* Tulasne, 'Note sur l'Appareil Reproducteur dans les Lichens et les Champignons,' Ann. des Sc. Nat., 3rd series, vol. xv.

miliar to Lichenologists—under the name of *Cephalodia* or other designations—as black tubercles, warts, or points on the thallus, or as black, deformed states of the apothecia, of various common Lichens, and especially of foliaceous species; but they have generally been regarded as abortive apothecia, or as parasitic fungi. In illustration, we may cite the black-punctate conditions of the thallus of *Parmelia conspersa* (var. *abortiva* of Schærer), *Parmelia saxatilis* (var. *parasitica* of Schærer), and *Sticta fuliginosa* (var. *abortiva* of Schærer), and the black, deformed state of the apothecia of *Sticta pulmonaria* (var. *pleurocarpa* of Schærer). "Lichenes in aliis parasitici normaliter nulli genuini," says Fries; a much too sweeping assertion, as has been satisfactorily proved by the recent researches of Continental Lichenologists. We know that many Fungi are parasitic on plants belonging to the same natural family; and there is good ground for the prediction that, when the more minute and hitherto little studied Lichens are thoroughly investigated by the aid of the microscope, we shall find the same phenomenon occurring among the Lichens, though perhaps not to the same extent. The presence of stylospores in two of the genera —*Abrothallus* and *Scutula*—has been regarded by some authors as a justification for placing them among the Fungi;


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but Tulasne regards them as truly lichenoid from their structure, consistence, duration, and the amyloid nature of some of their tissues, the parenchyma or reproductive organs of the Fungi never striking a blue colour with tincture of iodine. It cannot be denied however that the existence of these reproductive bodies approximates the genera in question most closely to certain sections of the Fungi; and we have here another interesting illustration of the affinities between the Lichens and cognate Cryptogamic families.

The parasitic genera to which we refer are *Abrothallus*, *Scutula*, *Celidium*, and *Phacopsis*. We mention them here, not because they are Angiocarpous Lichens, the reverse being the case, but because they have not yet found an appropriate resting-place in classification.

Genus I. ABROTHALLUS, *DNrs.**

Gen. Char. Apothecia burst through the thallus of the lichen, upon which they are parasitic; at first deplanate, afterwards generally pulviniform or globose-capitate, blackish, glabrous or furfuraceous, sessile, becoming free at the circumference, but having no annuliform margin or distinct exciple. Thecæ clavate, eight-

* De Notaris, Mem. della Reale Accad. delle Sc. di Torino, 2nd series, vol. x. (1849): and in Giorn. Bot. Ital., fasc. 3, 4 (1846): Montagne, Ann. des Sc. Nat., 3rd series, vol. x. and xvi.

spored, thick-walled. Paraphyses thickened and coalescing at apex. Spores ovate-oblong, or elliptic and obtuse at ends, or lanceolate, of a sooty-brown colour, bilocular, rarely simple; loculi unequal. Spermogones unknown. Pycnides utriform, immersed, simple, formed of a membrane at first pale and thickish, and having a black ostiole. Sterigmata very short or almost absent. Stylospores obovate and simple. (Name from ἁβρός, thin or delicate; an inappropriate designation, seeing that the genus is *athalline*. Tulasne suggests the word *Phymatopsis* as a preferable generic term; from φῦμα, a tuber, and ὄψις, like.)

This interesting genus is parasitic on various foliaceous Parmelias, Stictas, and Cetrarias. The pycnides in structure closely resemble the conceptacles in which are generated the stylospores of the *Hypoxyla* (Fungi).

1. Abrothallus Smithii (named in honour of Sir J. E. Smith, the distinguished author of the 'English Flora'). Apothecia pulviniform, prominent, black, sparingly greenish-pulverulent, or smooth. Spores bilocular, obovate, obtuse at ends, blackish or brownish; loculi somewhat unequal in size. Pycnides few or abundant, sometimes more numerous than the apothecia, punctiform, black, immersed, with a simple cavity; at first closed, afterwards having, according to age, a minute or gaping ostiole with a somewhat prominent margin. Sterigmata thick, very short, sometimes

inconspicuous. Stylospores obovate-globose and very obtuse, pale.

This species is the var. *parasitica* of *Parmelia saxatilis*, according to Schærer; the *Lichen parasiticus* of E. B. 1866; the *Endocarpon parasiticum*, Ach.; and the *Lecidea Parmeliarum* of Sommerfeldt. We have met with it in considerable abundance growing on furfuraceous forms or states of *Parmelia saxatilis* in two stations near Perth, viz. on Craigie Hill, Perth, and on Craig-y-Barns, Dunkeld. In both cases the *Parmelia* was found on an old wall, built of fragments of rock, or of boulders, belonging to the granitic or metamorphic series, especially gneiss. Hooker mentions its occurrence on var. *omphalodes* of *P. saxatilis*, at the foot of Ben Nevis and on the hill-moors of Ross-shire; and Tulasne on *Parmelia quercifolia*, var. *tiliacea* and *P. olivacea*. In specimens collected and examined by ourselves the plant grows on modified portions of the thallus of *P. saxatilis*. Sometimes these are simple, minute, and squamose; they then closely resemble the scale-like thalli of some of the Endocarpons, and the similarity is greater if they are dotted over with the point-like pycnides instead of the wart-like apothecia; these squamules appear truly separate from, and parasitic upon, the ordinary thallus of the *Parmelia saxatilis*,

but, like it, they are black-fibrillose below, and otherwise possess characters which justify our regarding them as belonging to that Lichen, and not to the parasitic *Abrothallus*, which is hence athalline. More usually however these portions of the thallus of the *Parmelia* are much deformed, apparently from a peculiar curling in of the laciniæ, and assume the character of irregularly globose, gnarled masses, dotted over with the black or greenish pulverulent apothecia of the *Abrothallus*. In the latter case we have frequently noticed them of a deep rusty-red colour, apparently from the imbibition of peroxide of iron from the stones or soil. This species of coloration, we have already seen, is somewhat common in alpine and subalpine saxicolous Lichens. The laciniæ of *P. saxatilis*, modified or deformed by the growth of the parasite, have been described by De Notaris as the proper thallus of the genus *Abrothallus;* hence the inappropriate name originally conferred on it by him. The pycnides of this species probably have not escaped the notice of previous Lichenographers. Fries appears to refer to them when he speaks of "*puncta verrucarioidea nigra*" of *Parmelia saxatilis*, which he regards as a less fully developed or younger state of the *cephalodia* of the same Lichen, the latter being the apothecia of *Abrothallus Smithii*, as

above described. Indeed the pycnides and apothecia of *A. Smithii* are very apt to be mistaken for different states of the same fructification. These pycnides are further liable to be confounded with *A. oxysporus*, which frequently grows along with *A. Smithii* on *P. saxatilis*, and whose punctiform apothecia resemble those of some Verrucarias. *A. oxysporus* has deplanate, immersed, scarcely prominent apothecia, with pale, lanceolate, unilocular spores. We have met with it, intermixed with *A. Smithii*, on Craigie Hill, Perth.

2. ABROTHALLUS WELWITZSCHII (named in honour of M. Welwitzsch, an accomplished Portuguese botanist). Apothecia green-pulverulent, girt by a raised ring of the cuticle of the thallus, on which they are parasitic. Spores ovate, bilocular, thick, black.

In general character this species resembles the preceding. It is the var. *abortiva* of *Sticta fuliginosa* according to Schærer. Specimens parasitic on *S. fuliginosa*, from rocks, New Cut, Meadfort, Torquay, Devonshire, are contained in Leighton's Lich. Brit. Exsicc. (No. 191, fasc. VI.) It was found by Welwitzsch on *Peltigera sylvatica* on the Serra de Cintra mountains, Portugal; and it constitutes the *cephalodia* which sometimes occur on the thallus of *Sticta limbata*.

Genus II. SCUTULA, *Tul.*

Gen. Char. Apothecia superficial on the thallus of various foliaceous lichens, scutiform or discoid, and immarginate. Thecæ clavate, 6–8-spored. Spores ovate-oblong, obtuse at ends, simple, pale, full of homogeneous oil. Spermogones globose, very minute, superficial, with a simple cavity. Spermatia linear, very slender, short, curved, generated acrogenously from simple, oblong-acute sterigmata. Pycnides globose, superficial, somewhat deplanate at apex, unilocular, thick-walled. Sterigmata short and simple. Stylospores oblong-cylindrical, obtuse at ends, curved, simple or rarely uniseptate. (Name from *scutula*, a little saucer, in allusion to the form of the apothecia.)

Only one species is described by Tulasne, viz.—

1. SCUTULA WALLROTHII (named in honour of M. Wallroth, a celebrated German cryptogamist). Apothecia small, disciform, flattish. Spores unilocular, ovate or ellipsoid, pale. Spermogones superficial, very minute, globose. Spermatia linear, curved, very delicate. Pycnides in form and site are similar to the spermogones; in structure they resemble those of the genus *Abrothallus*. Sterigmata linear-conical, simple. Stylospores oblong, straight or slightly curved, simple, rarely bilocular.

Tulasne mentions its occurring on various specimens of *Peltigera canina* from Germany and France.

Genus III. CELIDIUM, *Tul.*

Gen. Char. Apothecia epithalline, very minute (microscopic), pulvinate and immarginate, contiguous, and thickly associated in maculiform heaps; sometimes all, sometimes only the central ones, confluent. Thecæ clavate, four- to eight-spored. Spores simple or locular, ovate and oblong, pale. Spermogones globose, unilocular, generally seated in the centre of the maculæ. Spermatia slender, straight, short. Pycnides unknown. Parasitic on the thallus and apothecia of various foliaceous Lichens. (Name from κηλιδίον, a macula or spot, in allusion to the aggregated or confluent apothecia.)

1. CELIDIUM STICTARUM. Maculæ orbicular, black, continuous, frequently excavated in centre. Spores oblong-elliptic, quadrilocular. Spermogones globose and minute, aggregated and sometimes confluent, on the maculæ, or on the apothecia of the Lichen on which the species is parasitic. Spermatia very slender and straight.

This species is the var. *pleurocarpa* of *Sticta pulmonaria* according to Schærer, and it constitutes the black, fungous, abortive condition of the apothecia in that species. We have seen fine specimens of this state of the fructification of *S. pulmonaria* from the Forfarshire woods, and it does not appear to be very uncommon in Britain. The spores of the

parasitic *Celidium*, it will be observed, are very distinct from those of *S. pulmonaria*, which are lanceolate, acute at both ends, and usually bilocular. *C. Stictarum* also constitutes a deformed state of the apothecia of *Sticta scrobiculata* in some parts of Scotland; and it is the *Lecanora parasitica* of some Continental authors.

Genus IV. PHACOPSIS, *Tul.*

Gen. Char. Apothecia innate-adnate, at first concealed by thallus, afterwards naked or covered by a lacerated veil, black, effuse, constituting deformed maculæ or warts. Thecæ obovate, thick, six- to eight-spored. Spores oblong, few-septate, and pale. Spermogones commonly immersed in centre of apothecia. Spermatia slender, straight, short. Pycnides unknown. Parasitic on various foliaceous, fruticulose, and crustaceous lichens in Western Europe. (Name from φακός, a *nævus*, and ὄψις, like, in allusion to the black, fungiform maculæ or warts.)

1. PHACOPSIS VARIA. Spores oblong, obtuse at ends, quadrilocular, and pale. Spermogones, when present generally immersed in centre of maculæ, often absent. Spermatia straight and slender.—Tulasne mentions its occurrence on *Parmelia parietina*, both on its thallus and on the margin and disc of the apothecia.

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INDEX

TO THE

NATURAL ORDERS, GENERA, AND SPECIES.

(Synonyms are printed in Italics.)

	Page
Abrothallus	102, 311
oxysporus	315
Smithii	312
Welwitzschii	315
Alectoria (*vide* Cornicularia).	
Angiocarpi . . .	117, 120, 287
Arthonia	255
astroidea	255
Swartziana	255
Aulacographa	252
elegans	253
Bæomyces . .	61, 104, 116, 263
roseus	264
Biatora (*vide* Lecidea).	
Borrera ciliaris (*vide* Physcia).	
Borrera tenella (*vide* Parmelia stellaris).	
Buellia	238
Caliciaceæ	256
Calicium . 61, 62, 102, 109,	257
chrysocephalum	259
nigrum	259
——— var. curtum . . .	259
——— pusillum	259
——— *sessile* (*vide* C. turbinatum).	
——— sphærocephalum .	259
tigillare	257
turbinatum	258
Candelaria vulgaris	206

Page

Celidium 317
Stictarum 317
Cenomyce (*vide* Cladonia).
Cetrariaceæ 150
Cetraria . . 61, 72, 97, 109, 150
aculeata 105, 159
cucullata 160
glauca 150
——— var. fallax 151
Islandica . 81, 82, 83, 84, 91, 92, 105, 153
juniperina 151
——— var. pinastri . . 151
nivalis 152
sepincola 153
Chiodecton 295
albidum 295
Chiographa 252
Lyellii 252
Cladoniaceæ 261
Cladonia 36, 37, 43, 47, 58, 61, 63, 68, 72, 84, 97, 102, 104, 105, 109, 110, 264
alcicornis 269
bellidiflora 268
cervicornis 270
coccifera (*vide* C. extensa).
cornucopioides (*vide* C. extensa).
deformis 268

Page

Cladonia extensa 266
furcata 272
gracilis 270
Papillaria 275
pyxidata 97, 268
rangiferina . 82, 105, 226, 272
squamosa 271
——— var. fungiformis . 271
——— leptophylla . 271
——— microphylla . 271
——— parasitica . . 271
stellata 271
——— var. uncialis . . . 272
Collemaceæ 276, 285
Collema 54, 109, 116
atro-cæruleum 281
——— var. lacerum . 281
Burgesii 284
corniculatum 282
granosum 283
——— var. ceranoides . . 283
——— dermatinum . 283
multifidum 283
——— var. jacobæfolium 284
plicatile 285
pubescens 279
rupestre 282
——— var. fasciculare . . 283
——— furvum 283
Coniocarpon 256

Page

Coniocarpon cinnabarinum . . 256
Coniocybe 260
furfuracea 260
Cornulariaceæ 126
Cornularia . . . 37, 109, 123, 127, 203, 280
aculeata (*vide* Cetraria).
flavicans 129
jubata 127
—— var. bicolor . . 127, 128
—— cana 127
—— chalybeiformis . 127
—— prolixa 127
lanata (*vide* Parmelia Fahlunensis).
ochroleuca 129
—— var. cincinnata . 129
pubescens (*vide* Collema).
tristis (*vide* Parmelia Fahlunnensis).
vulpina 91, 130

Diplotomma 238

Endocarpaceæ 290
Endocarpon (*vide* also Sagedia).
athallum 146
miniatum 290, 293
—— var. complicatum . 291
—— umbilicatum . 291

Page

Endocarpon *parasiticum* . . 310
Smaragdulum 291
—— var. privigna . 292
—— rufescens . 292
—— smaragdulum 292
—— Sinopicum . 292
sorediatum 293

Ephebe pubescens 280
Evernia (*vide* Physcia).
Magellanica (foreign species) 100

Graphideaceæ . . 46, 60, 61, 101, 102, 110, 245
Graphis 60, 250
pulverulenta 250
scripta 250
serpentina 251
—— var. cutypa . . 251
—— recta . . . 251
Gyalecta 234, 300
cupularis 103, 234
Gymnocarpi . . 117, 119, 121
Gyrophora (*vide* Umbilicaria).
cylindrica 178
murina 173
proboscidea 178

Hymenodecton 251
dendriticum 251

Page

Hymenodecton dendriticum, var. Smithii 251

Isidium . . . 43, 218, 221, 297
oculatum 218

Lecanactis 253
lyncea 253
Lecanoreaceæ 214
Lecanora . 33, 42, 61, 89, 90, 96, 97, 102, 110, 214
affinis 211, 228
atra 103, 216
—— var. vulgaris 216
callopisma 216
crassa 214
—— var. cæspitosa . . . 214
esculenta (for. sp.) 51, 211, 228
cervina 292
Hæmatomma 227
murorum 215
pallescens 218, 219
———— var. parella 43, 67, 89, 208, 219
———————— Upsaliensis . 222
parasitica 318
rimosa 43, 218
rubra 227
subfusca . . 97, 216, 217, 218
——— var. crenulata . . 218

Page

Lecanora subfusca, var. leucopis 217
———————— pinastri 218
tartarea . . 89, 90, 102, 103, 105, 222
——— var. frigida . . . 224
———— saxorum . . . 223
varia 226
—— var. aitema 226
———— maculiformis . . 226
ventosa . . 62, 103, 105, 227
——— var. abortiva . . . 227
———————— lecidina . . . 227
Villarsii (for. sp.) (Plate XIII. figs. 1, 2, 3).
Lecideaceæ 234
Lecidea . . . 34, 45, 47, 51, 61, 96, 97, 100, 102, 103, 104, 105, 110, 235, 243
Lecidea æruginosa . . 104, 243
aurantiaca 103, 245
cæruleo-nigricans 236
calcarea 103
canescens 237
confluens 239
decipiens 104, 236
ferruginea 244
geographica 45, 101, 103, 238
———— var. alpicola . . 238
———————— atro-virens . 238
granulosa 104

Page

Lecidea *icmadophila* . . . 243
immersa 103
lurida 104
lutea 244
Parmeliarum 313
pineti 243
punctata 240
——— var. parasema . . 240
——— punctiformis . . 241
sanguinaria 241
sphæroides 242
——— var. effusa . . . 242
——— muscorum . 242
——— viridescens . 242
uliginosa 104
Lepraria (or *Lepra*) 34, 47, 206, 266
Lichen 24
ericetorum 243
parasiticus 313
pubescens 280
Lichinaceæ . . . 104, 116, 285
Lichina confinis 285
pygmæa 285
Limboriaceæ 307

Nephroma 161
resupinatum 161

Opegrapha (*vide* also Chiographa, Graphis, and Hymenodecton) 247

Page

Opegrapha atra 248
rupestris 248
saxatilis 247
varia 248
—— var. notha 248
——— tigrina 248
vulgata 249
——— var. vulgata . . . 249

Parmeliaceæ 181
Parmelia 35, 61, 62, 89, 90, 96, 97, 100, 101, 102, 109, 188
amplissima 44, 188
aquila 204
caperata 190
ceratophylla 196
——— var. multipuncta 196
——— physodes 42, 81, 197
conspersa 103, 201
——— var. abortiva . . 310
elegans 210
—— var. orbicularis . . 210
Fahlunensis . 47, 103, 105, 202
——— var. lanata 203, 280
——— stygia . . 203, 204
——— tristis 203, 204, 280
hypnorum 210
læte-virens 191
——— var. herbacea . . 191
olivacea . . . 101, 104, 202

Page
Parmelia parietina . 66, 69, 84, 91, 101, 104, 200, 205, 218, 318
——— var. Candelaria . . 206
——— viridis . . . 206
perlata 89, 190
plumbea 192
pulverulenta . . . 101, 193
saxatilis . . . 43, 56, 90, 197
——— var. omphalodes 56, 198, 200
——— parasitica 310, 313
stellaris 69, 101, 194
Peltideaceæ 161
Peltidea (*vide* Peltigera).
Peltigera . . 35, 36, 39, 61, 62, 63, 84, 97, 104, 162
aphthosa 164
canina . . 83, 165, 226, 316
—— var. spuria 165
——— ulorrhiza . . . 165
horizontalis 169
polydactyla 169
——— var. scutata . . 169
rufescens 170
sylvatica 170, 315
venosa . . . 104, 105, 163
Pertusaria (*vide* also Endocarpon and Sagedia) . . . 296
communis 67, 68, 69, 84, 104, 114, 258, 296
Phacopsis 318
varia 318
Phymatopsis 312
Physcia . . . 89, 109, 123, 144
chrysophthalma 149
ciliaris . . . 66, 69, 114, 145
furfuracea . . . 43, 84, 144
intricata 149
leucomelas 149
prunastri . . 81, 84, 100, 147
——— var. stictocera 147, 148
Placodium (*vide* Lecanora).
Platygramma 254
Hutchinsiæ 254
Porina (*vide* Pertusaria).
Psora, or *Psoroma* (*vide* Lecanora).
Pycnothelia (*vide* Cladonia).
Pyrenothea 307
leucocephala 308

Ramalina . 37, 62, 89, 97, 101, 109, 123, 137
farinacea 42, 138
fraxinea 81, 139, 148
——— var. ampliata . . . 139
——— calicaris . . . 139
——— fastigiata . . . 139
pollinaria 138
scopulorum 104, 142

Page

Roccella . . 37, 89, 90, 104, 131
dichotoma (for. sp.) . . . 135
flaccida (for. sp.) 135
fuciformis 89, 133
——— var. *linearis* (for. sp.) 135
Montagnei (for. sp.) . . . 135
phycopsis („) . . . 135
pygmæa („) . . . 135
tinctoria 89, 132
——— var. *hypomecha* (foreign species) 135

Sagedia 294
aggregata 294
cinerea 294
Scutula 102, 316
Wallrothii 316
Scyphophorus (*vide* Cladonia).
Segestrella 301
thelostoma 301
Solorina 171
crocea 105, 171
saccata 69, 172
Sphæria (Fungi) . . . 143, 284
Lichenum 146
Sphærophoraceæ 287
Sphærophoron . 36, 37, 62, 97, 257, 261, 287
compressum 289

Page

Sphærophoron coralloides . . 288
——— var. laxum . . 288
fragile (*vide* S. coralloides and S. compressum).
Squamaria (*vide* Parmelia).
Stereocaulon 37, 61, 62, 97, 104, 261
denudatum 263
nanum (*vide* S. quisquiliare).
paschale 261, 262
quisquiliare 262
Sticta 35, 42, 96, 100, 101, 181, 184
aurata 187
crocata 187
endochrysa (for. sp.) . . . 184
fuliginosa 186
——— var. abortiva . 310, 315
glomulifera (*vide* Parmelia amplissima).
herbacea (*vide* Parmelia læte-virens).
limbata 185, 315
macrophylla 186
pulmonaria . . 52, 83, 84, 93, 101, 181
——— var. pleurocarpa . 310, 317
scrobiculata 184, 318
sylvatica (*vide* Peltigera).
Strigula 308
Babingtonii 102, 309

Page

Syncesia (*vide* Chiodecton).

Thelotrema (*vide* also Pertusaria) 299
exanthematicum . . 69, 300
lepadinum 299

Umbilicariaceæ 173
Umbilicaria . . 82, 84, 89, 99, 100, 105, 173
erosa 180
polymorpha 177
——— var. cylindrica . 177, 178, 179
——— deusta . 178, 179
polyphylla 179
——— var. glabra . . 179
polyrrhizos 180
pustulata . . . 44, 89, 176
vellea 173
Urceolaria 89, 230, 300
calcarea 103, 232
——— var. concreta . . . 233
cinerea 230
scruposa 231
——— var. bryophila . . 231
——— diacapsis . . . 231
——— vulgaris . . . 231
Usneaceæ 121
Usnea . 24, 37, 61, 109, 121, 261

Page

Usnea barbata . . 92, 97, 101, 122
——— var. articulata 122, 125
——— ceratina . . . 122
——— dasypoga . . 122
——— florida . 122, 124
——— intestiniformis . 123
——— plicata . 122, 124
hirta (*vide* U. barbata).
melaxantha (for. sp.) . . 124

Variolaria 42, 297
amara 297
faginea 297
Verrucariaceæ 300
Verrucaria (*vide* also Pyrenothea, Sagedia, and Endocarpon) 302
Borreri 305
epidermidis 302
——— var. analepta . . 303
epigæa 307
gemmata 303
margacea 306
maura 104, 306
muralis 304
mutabilis 306
nitida 302
trachona 305
umbrina 305

GENERAL INDEX.

Absorption of organic and inorganic matters from the air and soil, 49, 50.
Acharius, classification of, 23, 27.
Acids, organic, colorific, 84; use of, in examination of minute tissues, 114.
Adhesion of the thallus, mode of, 36, 50.
Adherent thallus, forms of, 33.
Adnate apothecia, 62.
Adulteration of Lichen-dyes, 85.
Aerial nourishment of thallus, 50, 212, 229.
Affinity of Lichens to Algæ, 22, 55, 73, 115, 277, 285, 292; to Fungi, 22, 23, 24, 44, 46, 75, 115, 258, 308, 309, 310, 311; to Hepaticæ, 24, 116; to Mosses, 23, 116; to Phanerogamia, 38, 40, 91, 124, 261, 265.
African species, 134, 169, 187.
Age of Lichens, individual, 52; geologic, 53.
"Alaforel-laf" of Scandinavia, 200.
Algæ, affinity of Lichens to, (*vide* Affinity).
Alkalies, colouring matters tests for, 91.
Altitudinal range of Lichens, 100.
Alps, Lichens growing on the, 100, 101, 210, 226, 240, 263.
Alpine species, 13, 103, 105, 129, 151, 152, 154, 160, 172, 173, 174, 176, 178, 204, 210, 223, 226, 238, 239, 268, 276, 280.

American species, 30, 97, 123, 125, 134, 151, 153, 155, 164, 168, 169, 170, 187, 191, 196, 199, 209, 219, 228, 262, 269.
Ammonia, peculiar reaction on colorific principles, 228.
Ammoniacal maceration in developing dyes, use of, 86.
"Amorgos," "purple of," 86.
Amylaceous matters, chemistry of, 80, 81, 156.
Analysis, chemical, of ash of Lichens, 51, 137; of *Cetraria Islandica*, 155, 156; of *Parmelia parietina*, 208; of *Physcia prunastri*, 148; of *Roccella tinctoria*, 137.
Anatomy, microscopic, of vegetative system, 39; of reproductive system, 64.
Ancients, Lichen-dyes known to, 21.
Andes, Lichens growing on the, 101, 144, 199, 239, 263.
Angiocarpous fructification, 60, 63, 277, 282, 286, 287.
"Angola Orchella-weed," 134.
Animalcules, Lichens supposed to be metamorphosed into, 22.
Anodynes, use of Lichens as, 126.
Antarctic species, 97, 99, 100, 124, 143, 154, 162, 164, 169, 184, 187, 196, 199, 219, 226, 228, 239, 262, 263, 267, 268, 271, 289.
Antediluvian species, 53.
Anthelmintics, use as, 83, 164.
Antiscorbutics, use as, 158.
Apothecia, abortive or deformed states of, 62, 132, 201, 206, 217, 219, 226, 254, 255, 256, 276, 297, 310, 317; colour of, 63, 109, 266, 268; confluent or symphycarpeous, 61, 240, 265, 276; development of, 62, 63, 279; form of, 61, 279; classifications based on characters of, 26; position of, on thallus, 62; reaction of iodine on, 113; sorediiferous degeneration of, 297; structure of, 60; veiled, 62, 131, 163, 171.
Aphthæ, use in, 164.
Apparatus necessary for collecting and preserving Lichens, 3, 107, 109, 110.
Aquatic species, 291.
Arctic species, 96, 97, 99, 124, 128, 129, 153, 154, 162, 164, 170, 174, 199, 209, 226, 239, 262, 268, 269, 271, 289.

Arctic travellers, use of Lichens as food to, 5, 175.
Ardellæ, 255, 256.
Arenaceous rocks and soils, Lichens growing on, 103, 104.
Areolæ, thalline, 238.
Argillaceous rocks and soils, Lichens growing on, 104, 200, 264, 307.
Articulated thallus, 121, 122, 125.
Ash, chemical analysis of (*vide* Analysis).
"Ash-coloured Ground Liverwort," 165.
Astringents, use as, 83, 84, 93, 158, 183, 200, 209.
Athalline species, 46, 235, 246, 303, 309.
Author, experiments by, on dyeing properties, 88, 135.

Baking, use of, in, 80, 145, 148.
"Barbary Orchella-weed," 134.
Basalt, Lichens growing on, 103.
Bases of support, 50.
Bayrhoffer, speculations of, 281.
"Beard-moss," 123.
Beer-making, use of Lichens in, 93, 183.
Bibliography, general, 31, 76, 93, 105, 119, 319; special (not included in that appended to the various chapters), 40, 88, 121, 126, 135, 142, 145, 146, 159, 168, 181, 209, 210, 211, 230, 233, 235, 245, 257, 264, 266, 269, 270, 274, 278, 281, 287, 288, 294, 301, 308, 309, 311.
Biology of a Lichen, 32, 50.
Birdstuffer, use of Lichens to the, 123, 210, 275.
"Birks of Aberfeldy," Lichens coating cliffs at the, 227.
Bitter principles, chemistry of, 84, 145, 158, 175, 183, 209, 297.
"Blackalls-laf," of Scandinavia, 203.
"Bœttelet" of Sweden, 226.
Borrer, description of British species, 29.
Brazilian species, 30, 97, 199.

Bread, use of Lichens in making, 145, 148, 157, 275.
Brewing, use of Lichens in, 93, 183.
Brown dyes (*vide* Dyes).
Brownian movements of spores, 71, 292; of spermatia, 73.
Broth, use of Lichens as ingredients in, 157, 275.

Calcareous rocks or soils, Lichens growing on, 103, 104, 233, 300, 305.
Calico-printing, use in, 81, 142, 148.
Canadian hunters, use of Lichens as food by, 174.
"Canary Orchella-weed," 134.
"Canary Rock-moss," 190.
Candles, use in dyeing, 206.
"Cape Orchella-weed," 134.
Capillary thallus, 203.
Capitate apothecium, 256, 263.
Capitulate apothecium, 61.
Carbonaceous exciple, 173, 235, 247, 256, 257, 294, 301, 307.
Cartilaginous thallus, 276, 290.
Catarrhs, use in, 126.
Cattle, use of Lichens as fodder to (*vide* Fodder).
Cell-elements of vegetative and reproductive systems, 38, 39, 40, 45, 64, 166, 172.
Cellulose, 40, 81, 207.
Cell-wall, chemical nature of, 40, 65.
Cell-contents, 81.
Central apothecia, 62.
Cephalodia, 310, 314, 315.
Cephaloid apothecia, 261, 264.
Cetrarates, alkaline, influence of, in producing colour changes in thallus, 155; reactions of, with iron, 155.
Cetraric acid, 84, 155.

Chemistry of Lichens (*vide* Analysis, Colorific principles, *and* Colouring matters), 51, 52, 137, 155.
Chemical characters of Lichen-tissues, 112; chemical reagents, use of, in examination of Lichen-tissues, 112.
Chilblains, use of Lichens as application to, 142.
Chilian species, 30, 97, 123, 168, 199.
"Chink-wort," 247.
Chloride (or hypochlorite) of lime, use of, as a colorimeter, 87.
Chlorophylle, 39, 209, 277, 279.
Chimborazo, Lichens growing on, 101, 123.
Chrysophanic acid, 208.
Ciliated apothecia, 149, 159; spores, 292; thallus, 145, 149, 154, 177, 195.
Cinchona-barks, Lichens characteristic of, 102; Lichens as substitutes for, in medicine, 145, 209.
Classification, ancient and modern systems of, 18, 115; principles of natural and artificial systems, 25, 116.
Climate, effect of, on growth of thallus, 53; effect of, on distribution of species, 55, 98, 99.
Collection of Lichens, rules for, 3, 107, 109.
Collectors, value of individual and aggregate labours of, 15.
Colorific genera and species, enumeration of, 89; colorific species, rules for discrimination of, 88; colorific principles, chemistry of, 84; mode of evolution of, 86; tests for, 87; effects of external circumstances on quantity and value of, 56, 136.
Colouring matters, chemistry of, 84, 91; economical applications of, 48, 86; seat of, in thallus, 47; brown (*vide* Dyes); purple (*vide* Dyes); yellow (*vide* Dyes).
Confluent apothecia (*vide* Apothecia).
Coral islands, Lichens growing on, 80.
Coralloides, 24.
Coriaceous thallus, 35, 276, 283.

"Cork," or "Korkir," of the Scotch Highlands, 225.
Corrosion of rocks, 33, 50, 78.
Cortical tissue of thallus, structure of, 39, 143, 153, 162, 166, 176, 206, 263, 275, 277, 281, 288.
Corticolous species, 101, 104, 110, 246, 248, 257, 302.
Cosmopolite species, 97, 141, 273.
"Crab's-eye Lichen," 220.
"Crottles," "black;" 200, "brown," 184; "dark," 197; "light," 220; "white," 221; "stone," 191; botanical sources of, 90; economical applications of, 90, 199; mode of manufacture of, 86, 200, 225; value of, 201, 224; crottle-gathering in Scotland, 89, 90, 199.
Crustaceous species, 80, 88; crustaceous thallus, 33, 214, 247, 256, 290, 295, 301, 307.
Crystals, acicular, in thallus, 209; octohedral, 218, 232, 297.
Cudbear, botanical sources of, 89, 174, 224, 233; mode of manufacture of, 86, 225; Cudbear-Lichen, 224; gathering of, in Scotland, 225.
Cultivation of Lichens, 108.
Cutaneous eruptions, use in, 126.
Cymose fructification, 272.
Cyphellæ, 42, 171, 185, 191.

Decortication of the thallus, 121, 125, 265.
Demulcents, use as, 83, 129, 137, 148, 153, 156, 183, 269, 273.
Dendritic hypothallus, 45; thallus, 306.
Development of apothecia (*vide* Apothecia); thallus (*vide* Thallus); thecæ (*vide* Thecæ); spermatia (*vide* Spermatia); spores (*vide* Spores).
Detonating mixtures, ingredients in, 126.
Diagnosis of Cinchona barks by Lichens growing thereon, 102.
Diffluent thalamium (*vide* Thalamium).
Dillenius, classification of, 24.
Dimidiate perithecium, 60, 252, 302, 305.

Diœcious species, 280.
Disc, or sucker, adhesion of thallus by means of, 36.
Disintegration of rocks, 33, 50, 78.
Dried specimens of Lichens, use of examining, 121.
Dropsy, use in, 126.
Dyeing properties of British and foreign species, experiments on, 88, 135.
Dyes, from native and commercial Lichens, 84; botanical sources of, 89; chemistry of, 84; economical applications of, 86, 90; nomenclature of, 90; new commercial fields for export of, 135; value of, 136; rationale of manufacture of, 86; known to the ancients, 21, 85; brown, 92, 159, 179, 183, 197, 199, 200, 204; orange, 125, 220; red (crimson or scarlet), 128, 143, 145, 177, 179, 199, 201, 204, 208, 220, 221, 233; green, 179; purple or violet, 84, 179; yellow, 91, 130, 152, 153, 191, 206, 208, 209.
Dyspeptics, use of Lichen-jelly to, 157.

"Earth-bread," 230.
Economy of Nature, use of Lichens in, 77.
Economical applications of Lichens, 77; history of, in dyeing, 84; in medicine, 83; in miscellaneous arts, 92.
Edible species, 142, 197.
Effigurate thallus, 35, 235, 306.
Effuse thallus, 35, 249, 299, 301, 306.
Eggs, use of Lichens in dyeing, 209.
Emetics, use as, 165.
Emollients, use as, 137.
Endospore, structure of, 69, 195, 208, 221, 298.
Epidemic diseases of lower animals, use in, 183.
Epilepsy, use in, 200.
Epirrheology, 54, 98.
Epispore, structure of, 69, 208, 221, 298; coatings of, 69, 172, 207, 289, 298, 300, 303.

Epithalline growths, 56, 212.
Equivocal generation of Lichens, 22.
Erose thallus, 150.
Erratic species, 51, 211, 225.
Evernic acid, 84.
Examination of Lichen-tissues, rules for, 111.
Exciple, colour of, 64; proper, 61, 235, 257, 264, 279, 287, 301, 305, thalline, 60, 279, 290, 296, 299, 300.
Experiments on dyeing properties of Lichens, 88, 135.
Exogenous growth of thallus, 56; exogenous structure of Phanerogamia, resemblances to, 124.

"Fahln-laf" of Scandinavia, 203.
Fairy-rings, 56.
Fairies, use of Lichen-dyes by the, 199.
Farinose thallus and apothecia, 42, 193, 272.
Fastigiate thallus, 139, 255.
Fatty matters in the Lichen-thallus, 92, 155, 209.
Female disorders, use in, 126, 200.
Filaments, medullary, 39, 143, 304; moniliform, 277.
Filamentous species, 109; filamentous thallus, 37, 121, 279.
Fixuræ, 36, 39, 47, 161, 166, 171.
Florentine Orchill, 137.
Foliaceous species, 109; foliaceous thallus, 35, 150, 181, 276, 290.
Foliicolous species, 102, 305.
Fodder for animals, use as, 82, 125, 153, 157, 158, 228, 263, 274.
Food to man, use as, 51, 80, 228, 274.
Formation of soil, use in, 78, 235.
Fossil Lichens, 53.
Franklin, use of Lichens as food to, 175.
Fries, classification of, 27.

Frondose thallus, 35.
Fruticulose species, 109; fruticulose thallus, 36, 131, 272, 287.
Fumaric acid, 91, 155.
Fungi, affinity to (*vide* Affinity); parasitic, 59, 310.
Furfuraceous degeneration of thallus, 43, 144, 186, 197, 202, 279.

Gallic acid, 84, 155, 209.
Gærtner's theory of reproduction of Lichens, 25.
"Gelatinous Lichens," 276; gelatinous thallus, 276.
Geographical distribution of Lichens, 95, 124, 133, 141, 155, 164, 167, 178, 199, 219, 246, 269, 273, 289; horizontal distribution, 99; vertical, 100; irregularities in, 100, 184.
Geological age of Lichens, 53.
Germination of the spore (*vide* Spore).
Gibbi, 181.
Gliadine, 209.
Globose apothecia, 287, 290, 294, 301.
Globuli, 44.
Glomeruli, 44, 188.
Gonidia, structure, 40, 46, 192, 275, 277, 304; functions of, 41, 58.
Gonidic layer of thallus, 39; in hypertrophic or abnormal states, 41, 57, 265, 277, 304; gonidic reproduction, 41, 58.
Growth and decay of thallus, 50, 56.
Granitoid rocks, Lichens growing on, 103, 305.
Gum in the thallus, 40, 81, 93, 141, 148, 155, 158, 183, 197, 209, 267, 269, 279.
Gymnocarpous fructification, 60, 63, 277.
Gyrophoric acid, 84.
Gyrose apothecia, 173.

Habitat, nature of, 55, 101, 108, 212, 223; geological nature of, 103; physical nature of, 101; influence of, in producing varieties, 53, 105.
Hair-powders, use in the manufacture of, 92, 126, 142, 145, 275.
"Hazel-rag," or "Hazel-crottle," 184.
Herbaria, or fasciculi, of dried Lichens, consultation of, 29, 121.
Herbarium, preparation of specimens for the, 109.
Hedwig, speculations regarding reproduction, 24.
Hepaticæ, affinity to (*vide* Affinity).
Highlands, native dyes of the Scotch (*vide* Orchill).
Highlanders, Cudbear-Lichen gathering by the, 225.
Himalayas, Lichens growing on the, 97, 101, 141, 145, 147, 184, 185, 190, 191, 197, 239, 262.
Hoffmann's natural system of classification, 27.
Hooping-cough, use in, 125, 267, 269.
Hops, substitute for, in beer, 183.
Horizontal thallus, 33, 265.
"Horsetail Lichen," 127.
Hydrophobia, supposed specifics for, 168.
Hypothallus, form, 44, 71, 216, 217, 222, 226, 231, 238, 245, 278; structure and development, 44; duration, 45; metamorphoses of, 47.
Hypothecium, structure, 64; function, 68; reaction of iodine on, 113.
Hypoxyla (Fungi), affinity of certain sections of Lichens to the, 312.

"Iceland Moss," 82, 83, 154.
Icelanders, use of Lichens as food by, 157, 158, 159, 174.
"Idle-moss," 123.
Imbricated thallus, 35.
Immersed apothecia, 235, 293, 294, 301, 306.
Indian species, 123, 133, 135, 141, 168, 190.
Inflated thallus, 123, 196.
Innate apothecia, 62.

Innumerable spores, 292, 308.
Inorganic constituents of thallus (*vide* Analysis).
Intercellular substance, 40, 81.
Intermittent fevers, use in, 209, 267, 297.
Inuline, 80.
Invalids, use of Lichen-jelly to, 157, 183.
Iodine, reactions of, on tissues, 66, 111, 130, 207.
Iron, peroxide of, in thallus, 49, 52, 230, 240, 292, 314.
Isidioid degeneration of thallus, 43, 57, 202, 218, 219, 221, 223, 224, 264, 297.
Itzigsohn, discovery of spermogones by, 145.

Jaundice, reputed specifics in, 152.
Jelly, species yielding a, 83, 156, 175, 183.
"Jelly-Lichens," 276.

"Kenkerig" of Wales, 200.
"Korkalett" of Shetland, 225.

Laciniæ, thalline, 35.
Lakes, 86.
Lateral apothecia, 62.
Lava, Lichens growing on, 78, 263.
"Leaf-Lichens," 213.
Lecanoric acid, 84.
Leighton, researches of, 30, 117, 120, 245, 246.
Lens, use of pocket, in examining species, 111.
Leprose thallus, 34, 206, 218, 240, 257, 295, 300, 307.
"Letter-Lichens," 245.
Levantine Orchella-weeds, 137.
"Lichen," origin of name, 24.

"Lichenes exsiccati," or fasciculi of dried specimens, 29, 121.
"Lichen-hair," 127; lichen-starch, 80.
Lichenoides, 24.
Lichenology, history of rise and progress of, 18; advantages of knowledge of, 7, 8; incentives to study of, 11, 15.
Lichestearic acid, 155.
Light, effect of, on growth of thallus, 48.
"Lima Orchella-weeds," 134.
Lime, carbonate of, in thallus, 33, 209; phosphate, 156, 209; oxalate, 33, 137, 218, 229, 232, 297; tartrate, 137.
Limited distribution of certain species, 100, 164, 184.
Lindsay, Mr. Wallace, analyses of the ash of Lichens, 51, 148, 156.
Linnæus, classification of, 24.
Lirellæ, or lirellate apothecia, 61, 245.
Litmus, characters of, 85; adulterations of, 85; manufacture of, 85, 86, 224.
Living specimens, importance of examining, 107.
Lobes, thalline, 35.
Lowland species, 104.
"Lungs of Oak," or "Tree Lungwort," 183.

"Madagascar Orchella-weed," 134.
"Madeira Orchella-weed," 136.
Manna, 82, 213, 229; Mannite, 82.
Marginal apothecia, 62.
Maritime species, 11, 104, 132, 142, 306.
Maximum development of the thallus, 96.
Medicinal properties, 83.
Medullary tissue of thallus, 39, 162, 163, 166, 192, 277, 281.
Membranaceous thallus, 35, 253, 276.
Microscope, use of, in examination of tissues, 18, 21, 65, 111; directions for purchase of, 59.

Microscopic species, 309.
Mineralogical character of habitat, 103.
" Mogador Orchella-weed," 134.
Moisture, effects of, on growth of thallus, 48, 55, 71, 205.
Molecular movements, of spores (*vide* Spores); of spermatia (*vide* Spermatia).
Moniliform thallus, 121; moniliform filaments of medullary tissue, 277, 285.
Monœcious species, 281.
Mortar of walls, Lichens growing on, 304.
" Moss," term as applied to Lichens, 38, 123.
" Moss, Canary Rock," 190; " Common yellow wall," 209; " Iceland," 154; " Necklace," 125; " Norway Rock," 174; " Pustulatous," 177; " Swedish," 224; "Tartareous," 224; "Tree," 123; " Velutous or Velvet," 174.
Mosses (Lichens) used in dyeing, 91.
Mougeot and Nestler's 'Lichenes Exsiccati,' 121, 154.
Mucilage in thallus or apothecia, 279, 293, 298.
Mud, Lichens growing on, 104, 269.
Muscicolous species, 102, 222, 224, 231, 242, 281.
" Muscus arborei seu querni," 125.
Museums, collections of Lichens and Lichen-dyes in Scotch, 88.

Naked spores (*vide* Spores).
Natural system of classification, 27.
Necked apothecia, 294.
" Necklace Moss," 125.
New Holland species, 97, 123.
Nomenclature of British Lichens, 116.
Norwegian species, 154, 174, 177.
Norwegians, use of Lichens by the, 200.
Nostoc, affinity of Lichens to, 278.
Nova Zembla, Lichens of, 101.

Nutrients, use as, 82, 83, 129, 153, 156, 175, 183, 273.
Nutrient principles, chemistry of, 80; applications of, 82, 83.

Oils in the thallus, 92, 209.
Oil-globules in protoplasm of spores, 69, 241, 298, 300; of thecæ, 67.
Orcellic acid, 84.
"Orchella-weeds," 90, 134; botanical sources of, 135; geographical sources of, 134; commercial value, 136; economical applications, 86, 136; proposed substitutes for, 89; new fields of export of, 135.
Orchill, ancient and modern history of, 85; botanical sources of, 89, 135; chemistry of, 84, 86; economical applications of, 86; mode of manufacture of, 85, 86, 220; origin of name of, 131; commercial value of, 136; from native Lichens, 149, 173, 177, 179, 190, 221, 224, 233.
Orizabo, Lichens growing on, 174, 210, 269.
"Orn-mâssa" of Scandinavia, 223.
"Orseille d'Auvergne," 220.
Ostiole, 60, 287, 290, 294, 295, 296, 301, 306.
Oxalate of lime (*vide* Lime).
Oxalic acid, 91, 297.

Packing, use of, in, 93.
Paint, black, Lichens yielding a, 177.
Paper-making, use in, 93, 126, 142, 158.
Papillæ, thalline, 306.
Papillate apothecium, 173; papillate podetia, 275.
Papulose thallus, 279, 291.
Paramaleic acid, 91.
Paraphyses, colour, 64; structure and form, 64, 284, 293, 298; functions, 65; reaction of iodine on, 113.
Parasitic species, 258, 308, 309.
Parchment-making, use in, 93, 142.

Parietinic acid, 91, 208.
Patellate apothecia, 61, 132, 264.
Peaty soils, Lichens growing on, 104.
Pedicellate apothecia, 62.
Peltate apothecia, 61, 121, 161.
Pendulous thallus, 122, 127, 147.
"Perelle d'Auvergne," 220.
Perfumery, use in, 92, 126, 149, 275.
Perithecium, 60, 63, 287, 301, 305, 306, 307, 308; colour of, 63.
Picturesque, Lichens as elements in the, 80.
Pioneers of vegetation, use as, 78.
Physico-chemical characters of the tissues, 111.
Phthisis, use in, 137, 159.
Plague, reputed specifics for the, 200.
Podetium, morphology of, 37, 261, 264, 265, 275.
Poisonous properties, alleged, 131, 175, 229.
Position of Lichens in scale of vegetation, 22, 115.
Potash, bitartrate of, in thallus, 155; in ash of Lichens (*vide* Analysis).
"Poudre de Chypre," 92.
Preservation of specimens for herbarium, rules for, 109.
Progressive development theory, in relation to Lichen reproduction, 22.
Propagos, or buds, reproduction by, 25.
Protoplasm of spores, 147, 207, 208, 241, 242, 298, 300; of thecæ, 67, 70, 194, 257.
Pruinose thallus or apothecia, 42, 173, 193, 214, 231, 256.
Pulmonary diseases, use in, 137, 183, 267, 269.
"Pulver-laf" of Scandinavia, 193.
Pulverulent state of apothecia, 42, 260, 295, 308; of thallus, 41, 42, 57, 191, 205, 215, 217, 242, 262, 267.
Pulverulent thallus, 34, 247.
"Pulvis antilyssus," or "Pulvis contra rabiem," 83, 168; Pulvis Cyprius, 92.

Punctate condition of thallus (*vide* Thallus).
Punctiform apothecia, 241, 295.
Purgative properties, 83, 156, 158, 164, 175.
Purple dyes (*vide* Dyes); Purple of Amorgos, 86.
Pustulate thallus, 176.
Pycnides, 75, 309, 312.

Quartz rocks, Lichens growing on, 103, 239, 301.
Quinine, bitter principles of Lichens substitutes for, 145, 209.

"Rags," or "Raw," 184.
Rains of Manna, 229.
Reagents, chemical, use of, in examination of tissues, 111.
"Red Cup Moss," 267.
Red dyes (*vide* Dyes).
Red discoloration of thallus (*vide* Thallus).
"Reindeer Moss," 82, 96, 272.
Reindeer, use of Lichens as food by the, 128, 263, 273.
Reproductive system, primary, 57; secondary, 40, 57; speculations regarding, 25, 74.
Resin in the thallus, 137, 209.
Rhaphidian crystals in thallus, 209.
Rhizinæ, 36, 39, 293.
Rhubarb, colouring matters, resembling those of Lichens, 209.
"Rock Hair," 127.
"Rock Tripe," 174.
Rootlets, analogues of, in Lichens, 36.

Saccate apothecia, 172.
Salts, mineral, contained in thallus, 51.
Sandstone, Lichens growing on (*vide* Arenaceous).

Saxicolous species, 103, 104, 110, 124, 142, 247, 304.
Schærer's classification, 28, 117, 119.
Scriptures, Lichen-dyes probably alluded to in the, 85.
"Scripture-worts," 245.
"Scrottyie" of Shetland, 199.
Scurvy, use in, 158.
Scutellate apothecium, 61, 181, 276.
Scyphi, 264.
Seasons, effects on growth of thallus, 55.
Secondary and tertiary thallus, 37.
Septa of medullary filaments, 39, 45; of paraphyses, 65, 113; of spores, 147, 167, 244, 246, 282, 302.
Sessile apothecia, 62.
Sexuality of Lichens, speculations regarding, 25.
Shetlanders, use of Lichen-dyes by the, 199, 225.
"Shield-edge Lichens," 214.
Silica in the thallus, 52.
Siliceous soils, Lichens growing on (*vide* Arenaceous).
Snow-line, Lichens growing at or near the, 100.
Social Lichens, 273.
Soil-producers, Lichens as, 4, 78, 235.
Sodium, chloride of, in maritime species, 137.
Soredia, 41, 140, 187, 196, 297.
Sorediiferous degeneration of apothecia, 297; of thallus, 57, 140, 147, 148, 151, 187, 196, 197, 201, 216, 217, 223, 237, 297.
Sowerby's 'English Botany,' 29, 122.
Species, characters of British, 121; numerical distribution of, 99.
Specific virtues, reputed, in medicine, 83.
Spermatia, affinity to antherozoids, 73; escape from spermogone, 75; form, 73, 167, 316; development, 73; functions, 75; movements, 73, 275; reaction of iodine on, 113.

Spermogones, analogues, 73; colour, 72; density of, 73; form and structure, 71, 72, 275, 299, 303; original discovery of, 145; period of development, 73; position in relation to other parts of reproductive system, 72; mucilage of, 72.
Spontaneous generation of Lichens, 22.
Spores, agglutinated, 70, 257, 286, 289; abortive, 176, 242; arrangement in thecæ, 70, 289, 304; cellular or muriform, 68, 176, 232, 284, 293, 300; colour of, 69; contents, 69, 216, 221, 302; coatings of (*vide* Epispore); compound and simple, 68, 246; development of, 67, 70, 140, 147, 166, 286, 303; dissemination of, 70, 78; expulsion from thecæ, 67, 70, 71, 308; germination of, 44, 70, 172, 195, 207, 208, 221, 249; form, 68, 232, 239, 246, 258, 266, 288, 298, 302; size, 68, 293, 298; number, 67, 292, 308; structure, 68, 221; protoplasm of (*vide* Protoplasm); naked or extrathecal, 70, 258, 307; the nuclei of, 207; movements of, 71, 292; reaction of iodine on, 113; typical (for study), 146, 172, 298; unilocular and polylocular, 68, 246, 303; uniseptate and polyseptate, 68, 147, 246.
Spore-sac, 66; reaction of iodine on, 112; spore-wall, 69.
Squamulose state of apothecia, 43, 145, 193, 284; squamulose state of thallus, 261, 262, 265, 271; squamulose thallus, 35, 214, 236, 291, 294.
"Stane-raw," or "Staney-rag," 199.
Starchy matters in thallus, 80, 81, 112, 156, 175, 183, 209, 263, 267, 269.
Stearine, 209.
"Sten-laf" of Scandinavia, 197.
Sterigmata of spermatia, 72; of stylospores, 75, 312.
Sterility, causes of, 55.
Stipes, 37, 256, 257, 261, 262, 266.
Stipitate apothecia, 61, 257, 261.
"Stone crottle," 191.
Stylospores, 75, 309, 312.
Sugar and saccharine principles, 81, 155, 209.

Sulphuric acid, use of, in examination of tissues, 65, 111, 114, 207.
Swedes, use of Lichens by the, 131, 152, 164, 179, 183, 200, 206, 226.
Switzerland, Lichens of, 100, 149, 152, 170.
Symphycarpeous apothecia (*vide* Apothecia).
Synonymy, confusing state of, 280.
Synopsis of Natural Orders and Genera of British Lichens, 119.

Tannic acid, 84.
Tanning, use in, 93, 158, 183.
Tartareous thallus, 33, 219, 221, 222, 239, 263, 295.
Temperature of atmosphere, effects of, on growth of thallus, 54, 99; temperature of soils, ditto, 104.
Terminal apothecia, 62, 287.
Terrestrial nourishment of thallus, 50.
Terricolous species, 101, 104, 148, 307.
Thalamium, colour, 63; form, 60, 299; structure, 64, 299; nucleiform, 63, 287; multiple, 61, 295, 296; diffluent, 301, 307.
Thallus, abortive or rudimentary, 34; classification based on characters of, 26; cæspitose, 291; colour, 47, 163, 165, 180, 204, 278; consistence, 35, 278; black-punctate states of, 146, 147, 152, 196, 201, 310, 313; deformed states of, 41, 56, 140, 142, 148, 268, 314; dwarfed states, 148; erose, 180, 265; fastigiate, 139, 276, 288; essential tissues of, 46; form, 32, 292; development, 44; growth and decay, 50; varieties in form, 41, 53; squamose, 313; red discoloration of, 128, 155, 160, 230, 240, 272, 292, 314; non-adherent or free, 51, 211, 229; vertical or secondary, 265; horizontal or primary, 265; monophyllous and polyphyllous, 177, 179, 291; papillæform, 275.
Thecæ, chemical characters, 66; contents, 67; development, 67, 146, 293; disappearance, 67; form, 65, 207, 297; function, 67; rupture of, 67; reaction of iodine on, 66, 112, 207, 298; typical (for study), 146, 172, 297; unispored, 176, 242.

Thecæ and paraphyses, disaggregation of, by mineral acids, 114; by boiling the apothecium, 114.
Theories regarding the reproductive function, 25.
"Time-stains" (vernacular name), 4.
Tonics, use as, 83, 153, 156, 183.
Tournefort, classification of, 23.
"Tournesol," 137.
"Tousch," 179.
"Tree Hair," 127; "Tree Lungwort," 183; "Tree-moss," 123.
Trees, Lichens not destructive to, 102.
"Tripe de Roche," 82, 96, 174.
Tropical species, 96, 98, 133, 184, 246, 296.
Tubular tissue of medullary layer of thallus, reaction of iodine on, 114.
Tulasne, researches of, 23, 28, 310.
Typical British species, description of, 17, 117, 121.

"Ulf-mossa" of Scandinavia, 131.
Umbilicated thallus, 36, 173, 290.
Uniform thallus, 35, 235, 239, 305.
Upholstery, use of, in, 93.
Urceolate apothecia, 230, 234, 243, 299.
Usnea, 24.
Usnic acid, 266.

Varieties of species, causes of, 54, 98, 124.
Variolarioid state of apothecia, 216; of thallus, 57, 216, 221, 297.
Vegetable soil, use in creating, 78.
Vegetative system of Lichens, 32.
Veiled apothecia, 131, 296.
Ventricose podetia, 276.
Verrucæform apothecia, 61, 295, 296, 299, 301.

Vertical thallus, 86.
Vitality of Lichens, 54.
Vulpinic acid, 91.

"Wag-laf" of Scandinavia, 205.
"Wall-moss," or "Lichen, common yellow," 209.
Warts, thalline, 43, 57, 164, 296, 308.
"Wartworts," 301.
Wax in thallus, 137, 155, 209.
Weaving, use in, 93, 158.
"Weeds, Orchella," 90, 134.
Wild animals, food for, 82, 125, 153, 263, 274.
"Wolf's-moss," 131.

Yellow dyes (*vide* Dyes).

Zonate thallus, 56, 296.
Zones of altitudinal range, 100.

CORRECTIONS AND ADDITIONS.

Page 14, line 17. *For* "Although it is liable to separate, as its age increases, in annular masses, and it is habited by *Graphideæ* and *Lecideæ*, while it is seldom or never the habitat of the Ramalinas, Usneas, Physcias, or Cornicularias, which constitute the familiar 'beard' or 'moss' of aged trees," *read* "being seldom habited, to any extent, by the Ramalinas, Usneas, Physcias, and Cornicularias, which constitute the familiar 'beard' or 'moss' of aged trees."

Page 100, line 10. For "*Sphærophoron australe*," read "*Evernia Magellanica*."

Page 105, line 6. For "*Peltigera venosa*," read "*Verrucaria Hookeri*."

Page 161, line 11. *After* "kidneys," *add* "and ὁμός, like, in allusion to the form of the apothecia."

Page 188, line 15. *For* "probably from *parma*, a round buckler, in allusion to the form of the apothecium," *read* "from πάρμη, a round buckler, and εἰλέω, to enclose, in allusion to the thalamium being girt by a distinct border."

Page 213, line 14. For "*P. pulchella*, var. *cæsia*," read "*P. saxatilis*, var. *leucochroa*." Specimens from Melbury Hill, near Shaftesbury, Dorsetshire (sub nom. *P. saxatilis*, var. *concentrica*), may be examined in Leighton's 'Lich. Brit. Exsicc.' fasc. 8, no. 232 (1856).

Page 214, line 9. For "λεκάνη, a dish or platter," read "λεκάνιον, a small shield, and ὤρα, form."

Page 231, line 18. For "*bryophyta*," read "*bryophila*."

Page 235, line 9. For "λεκός, a dish," read "λεχίς, a small shield."

Page 257, line 4. *For* "probably from *calix*, a goblet," *read* "from καλύκιον, a little cup."

Page 268, line 8. For "*bellus*, beautiful," read "*bellis*, the daisy."


WESTLEYS

